Course catalog

M.Sc. (graduate) academic studies
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Analitical mechanics

ID: MSc-0825
responsible/holder professor: Jeremić M. Olivera

teaching professor/s: Zorić D. Nemanja, Jeremić M. Olivera

level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6

final exam: written

parent department: mechanics

semester.position: 1.1

goals

-To provide students knowledge of the fundamental principles and methods in Analytical Mechanics
-To enable students to solve practical problems in Analytical Mechanics using acquired knowledge in Analytical Mechanics
- to monitoring novelties in science and engineering

learning outcomes

-To enable students to master terms, methods and principles in Analytical Mechanics
-To enable students to relate the knowledge from knowledge in other scientific fields with knowledge Analytical Mechanics
-To apply knowledge from Analytical Mechanics in analysis, synthesis and prediction of solutions and consequences of problems in science
- To monitoring novelties in science and engineering

theoretical teaching


practical teaching

Lagrange’s mechanics and differential approaches. Elements of tensor calculus in analytical mechanics. Kinetic energy. Generalized forces. Virtual work principle. Lagrange-D’Alembert’s

prerequisite

Defined by curriculum.

learning resources

[5] Handouts

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 10
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)
feedback during course study: 0

test/colloquium: 60

laboratory exercises: 0

calculation tasks: 0

seminar works: 0

project design: 0

final exam: 40

requirements to take the exam (number of points): 0

references

Simić S. S., Analytical Mechanics, Fakultet tehničkih nauka, Univerzitet u Novom Sadu, Novi Sad, 2006

Vuković J., Selected topics in Mechanics, Written lectures for PhD studies, Mašinski fakultet u Beogradu, Beograd


Applied Aerodynamics

ID: MSc-0946
responsible/holder professor: Kostić A. Ivan
teaching professor/s: Bengin Č. Aleksandar, Kostić A. Ivan, Kostić P. Olivera, Mitrović B. Časlav
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: aerospace engineering
semester.position: 1.1

goals

The course objective is that students develop an understanding of practical applications of subsonic aerodynamics and to provide an introduction to compressible flows (lower transonic domain). The course initially covers concepts of airfoil theory, and the analysis of symmetric and cambered airfoils using analytical and numerical tools. The course also covers wing theory, lifting-line theory, elliptic wings, twisted wings, and their practical applications in the design of wings to meet the assigned aerodynamic requirements. Finally, students are involved in practical calculations of aerodynamic characteristics (lift, drag and the derived parameters) of the entire aircraft in configurations for take-off, landing and cruising flight in subsonic and lower transonic speed domains.

learning outcomes

After accomplishing the course, students should be capable of understanding and explaining various aspects of the relations between the body shape (airfoil, lifting surface, air vehicle) and its aerodynamic characteristics. In addition, the students must be able to recognize the opportunities for the application of the acquired knowledge for the solution of different, both aeronautical, and non-aeronautical practical problems.

theoretical teaching

In the theoretical part of course the following topics are analyzed. Two-dimensional problems: airfoil characteristics: the method of singularities, thin airfoil theory, method of droplets, panel methods, empirical methods and the determination of aerodynamic loads. Three-dimensional problems: vortex wing models, the theory of lifting line, analysis of elliptic wing, twisted non-elliptic wings, influence of geometric parameters on aerodynamic characteristics, loading of wings of arbitrary shape. Aerodynamic characteristics of complete aircraft. Wing airfoils selection, lifting characteristics and drag of wing and complete aircraft in take-off and landing configurations, and in cruising flight at subsonic and lower transonic speeds. Role of the CFD in the analysis and determination of aerodynamic characteristics.

practical teaching

In the practical part of the course professor demonstrates the numerical examples in various areas. Practical work of students is accomplished through a virtual laboratory, available 24 hours (program MOODLE). In the workshop students have access to the professor's lectures (handouts), assignments for practice and tests. Practical training includes the preparation of project (calculations of aerodynamic characteristics of a selected aircraft). Project is performed by each student individually.
prerequisite

None. Students who did not take any of aerodynamics courses on bachelor studies are referred to the additional handouts by professor.

learning resources

This course has a virtual classroom on the Internet. At the first lecture students are enrolled and trained for work in Moodle software package. In the workshop, students have access to lectures and exercises, guidelines for project design, internet resources, etc.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 5
seminar works: 0
project design: 5
consultations: 10
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 5
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 30
requirements to take the exam (number of points): 25

references
I. Kostić, Handouts in Applied Aerodynamics, University of Belgrade, Faculty of Mechanical Engineering, Belgrade 2014.
C/C++

**ID:** MSc-0508  
**responsible/holder professor:** Bengin Č. Aleksandar  
**teaching professor/s:** Bengin Č. Aleksandar, Vorotović S. Goran, Lazović M. Goran, Mitrović B. Časlav  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** project design  
**parent department:** information technologies  
**semester.position:** 1.1

**goals**

- Introduce to C/C++; Structure of C/C++ and usability.  
- Simple problems in mechanical engineering using C/C++.  
- Art of pointers.  
- Saving acquisition data in files, use that files and discussion results.

**learning outcomes**

After successful completion of the program provided for in this case the student can:  
- Programing simple programs in C/C++ to solve problems in mechanical engineering.  
- Use basic patterns in C/C++.  
- Use pointers and simple data structures.  
- Solve simple mechanical engineering problems with acquisition data in files.

**theoretical teaching**


**practical teaching**

Workshops with basic examples in C/C++.

**prerequisite**

Knowledge of Programming, Computer tools, Numerical methods, Mathematics 1, Mathematics 2.

**learning resources**

The necessary software for this case under the GNU license - free of charge. If necessary use the Linux C/C++ is available to you immediately. If you use another operating system, C/C++ can be downloaded from the appropriate Web site (see URL) or the URL. To run the software necessary to possess enough simplest PC.

**number of hours**

Faculty of Mechanical engineering — course catalog — M.Sc. (graduate) academic studies
total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 8
laboratory exercises: 17
calculation tasks: 0
seminar works: 8
project design: 4
consultations: 0
discussion and workshop: 3
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 4
check and assessment of projects: 4
colloquium, with assessment: 0
test, with assessment: 2
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 35
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Computer control

ID: MSc-0631
responsible/holder professor: Bučevac M. Zoran
teaching professor/s: Bučevac M. Zoran
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: control engineering
semester.position: 1.1

goals

• Introducing of: nature of computer control systems-CCS related to types of signal transfer; real CCS as mainly presented in the practice; choice of physical model of CCS; mathematical modeling of CCS.
• Mastering of: methods of determining of static and dynamic characteristics of CCS; real time computer control by discrete algorithms.
• Off line use of MATLAB - but as software standard of automatic control.

learning outcomes

• Exact but not approximate treatment of CCS according to their nature.
• Scientific and engineering treatment of CCS as dominantly represented in practice.
• Applying the methods of analysis and synthesis of controller in CCS, as well of whole CCS.
• Solving problems of calculation nature by means of computer and MATLAB in the "off line" mode, related to the analysis or synthesis of CCS.
• Determining of dynamic and static characteristics of CCS.

theoretical teaching

• Introduction in Computer Control-CC: specific nature of CCS, importance and examples
• Samplers, quantization and coding: real and ideal samplers, mathematical description, technical realization; description of quantization and coding
• Complex and frequency images of ideal sampler output: determination; Shannon's theorem
• CCS transfer characteristics: definition in the frequency and s-domain
• Systems for signal duration extension: definition, analysis and transfer characteristics
• Z-transform: definition, transfer characteristics in z-domain
• Block diagrams of CCS: algebra of s and z block diagrams
• Modeling and analysis of CCS: classical mathematical modeling, static characteristics and types of action
• State concept of CCS: modern mathematical modeling, properties and solving
• Dynamic properties of CCS: definitions, determining, criteria

practical teaching

PA:

Examples, determining:
• graphically, of signal in receiver; of physical real CCS
• analytically, x*(t); of quantization and coding
• X*(s) and X*(jω); application of Shannon's theorem
• of discrete transfer characteristics
• transfer characteristics of holds and analysis
• of z-images; of originals
Examples:
• applying of z-block algebra;
• discretization of differential behavior equation; determining of discrete state and output
equations; determining of motion and response
• testing of controllability, observability, stability

PL:

Determining in MATLAB:
• Simulation of different types of signal transfer
  • X*(s) and X*(jω)
  • hold characteristics
• z-images, originals
• discrete mathematical models
• dynamical properties
• sampler output response at oscilloscope
• CC of physical object in real time

PZ:

• Manipulation with mathematical models, determining of static and dynamic characteristics

prerequisite

• Basic knowledge of automatic control.
• Basic computer knowledge based on use of PC.
• Basic knowledge of undergraduate mathematics.

learning resources

1. Manuscript at http://au.mas.bg.ac.rs/Nastava-Kau/Nastava_Download.htm, DVL
2. Ljubomir Grujić: Discrete systems (in Serbian), Mechanical engineering faculty, Belgrade 1991, KDA, library and bookstore of MEFB
3. Power supply, function generator, oscilloscope, lab. for Digital control systems, EOP/LEO
4. Protoboards, integrated circuits, ADDA electronic card, Lab. for Digital control systems, EOP/LEO
5. Object of control, Lab. for Digital control systems, EOP/LPI
6. Licensed and freeware software, MEFB
6. PCs, Lab. for Digital control systems and computer lab. MEFB

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 16
laboratory exercises: 13
calculation tasks: 1
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 1
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 2
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 45
laboratory exercises: 10
calculation tasks: 10
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**

Ljubomir Grujić: Discrete systems (in Serbian), Mechanical engineering faculty, Belgrade 1991, KDA, library and bookstore of MEFB
Engineering materials 3

ID: MSc-0892
**responsible/holder professor:** Bakić M. Gordana
**teaching professor/s:** Bakić M. Gordana
**level of studies:** M.Sc. (graduate) academic studies
**ECTS credits:** 4
**final exam:** written+oral
**parent department:** engineering materials and welding, tribology, fuels and combustion
**semester.position:** 1.1

**goals**

The aim of this course is to introduce students to different types of engineering materials and their properties with the goal of understanding and studying the possibility of their application for manufacturing of different elements and constructions. Special attention is devoted to studying the influence of composition, thermal processing and processing by plastic deformation on the structure and properties of the material. This course enables possible collaborations with institutes, companies and factories that make and construct engineering materials and deal with their application.

**learning outcomes**

Upon the successful completion of the course, students are able to:
- solve specific problems in the fields of detecting and recognizing damages in metallic structures and welded joints in particular;
- determine the potential causes of damage;
- perceive the eventual possibilities for preventing the occurrence of damage;
- define the testing programme for detecting damages in mechanical structures;
- prescribe maintenance measures for preventing damage in mechanical structures;
- relate the acquired knowledge to other fields, with practical applications.

**theoretical teaching**


**practical teaching**


**prerequisite**

Necessary conditions: Engineering materials 1 and 2.
Desired condition: Physics and Strength of material.

**learning resources**

1. Л. Шићанин, Машински материјали 2, ФТН-Нови Сад, 1996, КДА
2. Шуман Х., Металографија, ТМФ - Београд, 1981, КДА

**number of hours**

total number of hours: 45

**active teaching (theoretical)**

lectures: 12

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 7
seminar works: 8
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 1
test, with assessment: 2
final exam: 3

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 25
laboratory exercises: 0
calculation tasks: 15
seminar works: 20
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

**references**
Facility layout and industrial logistics

ID: MSc-0187
responsible/holder professor: Kosanić Ž. Nenad
teaching professor/s: Kosanić Ž. Nenad
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: material handling, construction and logistics
semester.position: 1.1

goals

Introducing the students into the factories, factory facilities, transport and warehouse systems design process logic is the main goal. Development of the student system design creative and innovative abilities in order to increase the production, warehouse and logistic activities efficiency, contributing to the overall country industrial development is also the main issue.

learning outcomes

Upon successful completion of this course, students should be able to:

- Make a project requirement for factory, factory facilities, transport, storage and logistic systems planning.
- Make a calculation of needed technological and additional equipment, working power, working places, needed areas and material flow.
- Make a layout of the factory, factory facilities, transport, storage and logistic systems.
- Calculate the basic elementary subsystems performances (by queueing systems modeling) of the factory, factory facilities, transport, storage and logistic systems.
- Make a cast iron foundry concept study.

theoretical teaching


practical teaching

Queuing model choosing for characteristic production and transport processes modeling. Computer calculation of queuing models statistics (outcome working parameters). Foundry concept study: Smeltery department production equipment needs estimation; Molding sand preparation department technology choosing and production equipment needs estimation; Core sand preparation department technology choosing and production equipment needs estimation; Mold cleaning department technology choosing and production equipment needs estimation;
estimation; Foundry warehouse design; Some department crane or conveyer basic design
parameters and capacity estimation; Foundry layout design; Foundry one department detailed
layout design. Consulting and recommendations for factories, factory facilities, transport and
logistic (warehouse-distributive) subsystems and systems modeling and designing.

prerequisite

Needed: Passed Subject: Mathematical probability and statistics, Material handling equipment,
Fundamental of steel structures in heavy machinery.

learning resources

1, Dj. Zrnic, Facility layout design, Faculty of mechanical engineering, University of Belgrade,
1993.; 2, Dj. Zrnic, M. Prokic, P. Milovic, Foundry layout design, Faculty of mechanical
engineering, University of Belgrade, 1998.; 3, Dj. Zrnic, D. Savic, Material flow simulation,
Faculty of mechanical engineering, University of Belgrade, 1997.; 4, Dj. Zrnic, D. Petrovic,
Facility layout design solved example problems, Faculty of mechanical engineering,
University of Belgrade., 1992.; 5, Queuing models software package, Faculty of mechanical
engineering, University of Belgrade, 1999., lab, 459.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 0
laboratory exercises: 3
calculation tasks: 0
seminar works: 0
project design: 35
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 3
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 30
requirements to take the exam (number of points): 35

references

Dj. Zrnic, Facility layout design, Faculty of mechanical engineering, University of Belgrade, 1993.
Dj. Zrnic, D. Savic, Material flow simulation, Faculty of mechanical engineering, University of Belgrade, 1997.
Dj. Zrnic, D. Petrovic, Facility layout design solved example problems, Faculty of mechanical engineering, University of Belgrade, 1992.
Queuing models software package, Faculty of mechanical engineering, University of Belgrade, 1999., lab, 459.
Fuel, Lubricants and Industrial Water 2

ID: MSc-0893  
responsible/holder professor: Jovanović V. Vladimir  
teaching professor/s: Jovanović V. Vladimir, Manić G. Nebojša, Stojiljković D. Dragoslava  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 2  
final exam: written  
parent department: engineering materials and welding, tribology, fuels and combustion  
semester.position: 1.1

goals


learning outcomes

Upon completion of this course students should be able to:
1 Define the concept of fuel, the criteria for the characterization of fuel and fuel types according to the adopted criteria, calculate the amount and composition of the combustion products and combustion temperature.
2 Define basic characteristics of solid fuels: moisture content, mineral content, the volatile content, carbon residue content, heating value.
3 Define basic characteristics of liquid fuel: behavior at elevated temperatures, behavior of low temperatures, density, water content and mechanical impurities, volatility, viscosity, resistance to detonation and inflammability.
4 Define the role of lubricants in engineering and basic characteristics of them.
5 Define the role of water for industrial applications and the most important characteristic: hardness and acidity.

theoretical teaching


practical teaching

The conversion from one to another mass of solid fuel. Calculation of heating value of the fuel. Elements of stoichiometry. Combustion temperature. Determination the characteristics of proximate analysis of solid fuels. Determination of heating value of solid and liquid fuels with a bomb calorimeter and the determination of heating value of gaseous and liquid fuels with Junkers calorimeter. Determination of the distillation curve. The significance of the main temperature on distillation curve. Characteristics of fuels at elevated and reduced...
temperatures. Quality control. Determination of the viscosity of liquid fuels and lubricants (dynamic, kinematic viscosity and relative). Determination of the basic characteristics of grease. Determination of water hardness and acidity.

**prerequisite**

No special requirements.

**learning resources**

Milan Radovanovic: Fuels; Milan Radovanovic: Industrial water; Aleksandar Rac: Lubricants; M. Adzic, A. Rac, S. Memetović: Manual for laboratory exercises in Fuels;

**number of hours**

total number of hours: 30

**active teaching (theoretical)**

lectures: 15

**active teaching (practical)**

auditory exercises: 1
laboratory exercises: 9
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 1
test, with assessment: 2
final exam: 2

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 40
laboratory exercises: 10
calculation tasks: 5
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 20

**references**
Manufacturing Automation

ID: MSc-0785
responsible/holder professor: Jakovljević B. Živana
teaching professor/s: Jakovljević B. Živana
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: production engineering
semester.position: 1.1

goals

The objective of this course is that students: acquire knowledge of the application, design and implementation of contemporary manufacturing automation; master the skills of practical problem-solving in the domain of automation by using computer, information, control, manufacturing, and other technologies and appropriate scientific methods

learning outcomes

After successfully completing this course, the students should be capable to:
- Analyze social, economic, production and other effects of automation;
- Integrate knowledge in related subjects and implement them in automation;
- Analyze and synthesize combinational automata;
- Synthesize sequential automata;
- Carry out pneumatic and electro-pneumatic realization of combinational and sequential automata;
- Program programmable logic controllers according to IEC 61131-3.

theoretical teaching

1. Introduction to manufacturing automation: definition of automation; types of production systems automation; fixed, flexible, programmable and intelligent automation; advantages and disadvantages of automation
2. Number systems: additive number systems; positional number systems (decimal, binary, octal, hexadecimal); conversion of numbers between positional number systems
3. Codes and coding: binary coded decimal; conversion between binary coded decimal and binary number system; Gray code; alphanumerical codes
4. Switching algebra: axioms of Boolean algebra; elementary operations of switching algebra; theorems of switching algebra; logic functions; canonical forms of logic functions (sum of minterms and product of maxterms); minimization of logic functions
5. Technologies and components for realization of control tasks in manufacturing automation: the structure of control system - subsystems for information acquisition, information processing and command execution; pneumatic and electro-pneumatic realization; sensors, actuators, logical and memory elements.
6. Combinational and sequential automata: Definition, models, synthesis and analysis; Pneumatic and electro-pneumatic realization
7. Programmable logical controllers: functions, hardware, software, input-output modules; programming languages and programming according to IEC 61131-3.
8. Examples of manufacturing automation

practical teaching
1. Auditory exercises: examples in automation design, with control system analysis and synthesis, programmable controllers programming, and control scheme design.

2. Laboratory exercises:
   PL1 Control of pneumatic actuators
   PL2 Analysis of combinational automaton (pneumatic realization)
   PL3 Synthesis of combinational automaton (pneumatic realization)
   PL4 Synthesis of combinational automaton (electro-pneumatic realization using PLC)
   PL5 Synthesis of sequential automaton (electro-pneumatic realization with PLC)
   PL6 Synthesis of sequential automaton (electro-pneumatic realization with PLC- timers and counters)
   PL7 Synthesis of sequential automaton (electro-pneumatic realization using PLC and programming in sequential function charts)

3. Seminar work: examples of automation design with control system synthesis, programmable controllers programming and control scheme design.

prerequisite

none

learning resources

2. Pilipović M., Manufacturing processes automation: Laboratory. FME, Belgrade, /In Serbian/
3. Jakovljevic, Z., Manufacturing automation, lecture handouts
4. Laboratory desk with electro-pneumatic components and programmable controllers, Laboratory for manufacturing automation.
7. Software for programmable controller programming, Laboratory for manufacturing automation.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 14
calculation tasks: 0
seminar works: 4
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks
check and assessment of calculation tasks: 0
check and assessment of lab reports: 4
check and assessment of seminar works: 2
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 4
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 20
laboratory exercises: 10
calculation tasks: 0
seminar works: 15
project design: 0
final exam: 50
requirements to take the exam (number of points): 30

**references**

Operations Research

**ID:** MSc-0421  
**responsible/holder professor:** Bugarić S. Uglješa  
**teaching professor/s:** Bugarić S. Uglješa  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** industrial engineering  
**semester.position:** 1.1

**goals**

Course goal is overwhelm with academic and scientific methods and quantitative techniques for obtaining alternative (optimal) solutions of real world problems on which basis user can perform analysis and synthesis of given solutions, make decision and predict consequences.

**learning outcomes**

Solution of concrete problems with application of scientific methods, procedures and techniques using analysis, synthesis and prediction of solutions and consequences as well as overwhelm with methods, procedures and research processes and application of knowledge (gained skills) in practice.

**theoretical teaching**


**practical teaching**

Audit lessons (examples of linear programming, transportation problem, nonlinear programming, dynamical programming. Examples of project management – structure analysis, time analysis cost analysis. Examples of application of queuing theory models – finite and infinite source of customers, single and multi server without and with partial and complete help between servers. Examples of service system optimisation. Application of simulation and Monte Carlo method in analysis and modelling of service systems. Examples from area of decision making and forecasting. ). Laboratory work (the use of adequate software).

**prerequisite**

There is no special conditions needed for course attending

**learning resources**
5. Software: QSopt Version 1.0 (Linear programming problems).
7. Software: MS – Project (Project management).
8. Personal computers.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 21
laboratory exercises: 9
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 1
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 9
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**
Physics of explosive processes

**ID:** MSc-1136  
**responsible/holder professor:** Elek M. Predrag  
**teaching professor/s:** Elek M. Predrag, Jaramaz S. Slobodan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** weapon systems  
**semester.position:** 1.1  

**goals**

The goal of course is that students learn the basic principles of combustion of materials and physics of explosion which are of importance for the realization of a function of weapon systems. Students should learn the contents of the process of explosion and burning of gunpowder and rocket propulsion materials as integrated chemical-technological systems.

**learning outcomes**

Student gets knowledge for calculations of physics of explosion processes that influence warhead mechanisms and target efficiency. Student understand influencing parameters on the energy release by combustion processes. Student forms the scientific and experimental base for the development and creation of new knowledge in the field of energetic materials and energy release processes in defense technologies.

**theoretical teaching**

1. Fundamentals of thermochemistry and thermodynamics of the explosive processes  
2. Explosives sensitivity to external influences  
3. Fundamentals of the hydrodynamic theory of detonation  
4. The effect of explosions on the surrounding environment  
5. Contact detonations. Active part of the explosive charge  
6. Explosive propulsion. The formation of plane detonation wave  
7. General assumptions and laws of ignition of fuel-oxidizer systems and exothermic reaction  
8. Combustion of solid rocket propellants, powders and pyrotechnic mixtures (kinetics and thermochemistry)  
9. Combustion products and energy characteristics of the various types of fuel mixtures and methods of measuring the burning rate

**practical teaching**

1. Calculation of thermochemistry and thermodynamics of the explosive processes  
2. Explosives sensitivity to external influences. Applications  
3. Fundamentals of the hydrodynamic theory of detonation. Selected examples  
4. The effect of explosions on the surrounding environment. Selected examples  
5. Contact detonations. Active part of the explosive charge  
6. Explosive propulsion. The formation of plane detonation wave. Examples  
7. Ignition and combustion of gas and liquid reactants and boundary conditions  
8. Kinetic properties of powder and rocket propellants and models of decomposition of solid fuels  
9. External influences and methods of measuring kinetic and energy parameters in different environmental conditions
prerequisite

There are no obligatory prerequisites. Passed exam preferred: Fundamentals of projectile propulsion

learning resources


number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 6
laboratory exercises: 8
calculation tasks: 16
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 10
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 60
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Product Aesthetics

ID: MSc-0270
responsible/holder professor: Popkonstantinović D. Branislav
teaching professor/s: Popkonstantinović D. Branislav
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: theory of mechanisms and machines
semester.position: 1.1

goals

Introduce students to the standards and laws of aesthetics in the process of product design, recognizing the subjective and objective factors of establishing the aesthetic judgement; introduction to the cultural and historical aspects and schools of aesthetics; treatment of aesthetic elements and principles, the study of geometric harmony laws, the use of traditional and modern means of creating aesthetic properties; introduction to the features of modern graphical signs and aesthetic properties of packaging and advertising.

learning outcomes

Student has gained the ability of aesthetic evaluation and the formation of aesthetic judgement, through theoretical and practical courses, student is trained to creatively use both abstract elements and principles of aesthetics and practicality (classical and modern) means of creating aesthetic characteristics of the product;

theoretical teaching

Aesthetics definition and etymology of the name; concept, factors and aesthetic significance of the judgement of sentiment and aesthetic standards; explanation of the relativity of aesthetic judgement through a short presentation on the history and origin of aesthetics; aesthetics as a factor of visual communications, detailed analysis of the aesthetic elements of Product design, processing and analysis of basic aesthetic principles of Products design; processing of geometric principles as essential factors of aesthetics of visual communication; concept of the composition harmony, methods of creating and presenting aesthetic properties (classical and modern); sketching and drawing the basic principles of oblique projections, orthogonal axonometry, central projections and prospective, Principles of computer modeling using the appropriate forms CAD software; the concept of modern graphical signs and symbols; the role of graphic symbols in the context of contemporary visual communications; aesthetics of signs, symbols and meanings; aesthetic properties of product packaging, advertising and product presentations;

practical teaching

Independent analysis, creation and presentation of examples on aesthetic universal attitude and the basic principles of induction of aesthetic value, aesthetic evaluation, discussion on cultural and historical aspects of aesthetics, training the use of aesthetic elements and principles; constructive analysis of classical geometrical laws of aesthetics; exercises using classical and contemporary means of creating and presenting the aesthetic properties of products; exercise in creating graphical symbols and signs with an emphasis on aesthetic visual meaning;
prerequisite

Required: Passed courses Constructive Geometry and Engineering Graphics. Desirable: Passed courses Machine elements 1 and 2

learning resources

Script: The aesthetics of the product, by Branislav Popkonstantinović; need additional materials (handouts, exercises, essay titles, etc..) are given at the web site or reproduced on paper. Large-scale electronic materials can be made available to students in direct contact. Teaching is done by combining video images and tables.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 7
laboratory exercises: 6
calculation tasks: 7
seminar works: 7
project design: 0
consultations: 3
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 2
check and assessment of seminar works: 2
check and assessment of projects: 0
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 40
laboratory exercises: 10
calculation tasks: 10
seminar works: 10
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Rail vehicles 1

ID: MSc-1186
responsible/holder professor: Milković D. Dragan
teaching professor/s: Milković D. Dragan, Simić Ž. Goran
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: railway mechanical engineering
semester.position: 1.1

goals

1. Understanding of different constructions of the freight wagons and passenger coaches
2. Acquiring the knowledge necessary to understand the functioning of wagon or coach assemblies
3. Application of knowledge in the design, development, repair and maintenance of wagons and coaches

learning outcomes

After completion of the course the student should be able to:
1. Explain the functional and structural characteristics of various types of rolling stock.
2. Explain the tasks and functioning principles of the assemblies of the rail vehicles.
3. Identify actions required to resolve failures in operation and maintenance of rail vehicles.
4. Apply appropriate regulations and standards for design and maintenance of railway vehicles.
5. Applicate computer tools for calculating and designing rail vehicles.

theoretical teaching


practical teaching


**prerequisite**

Previously finished equivalent of at least: 12 ECTS in Mechanics of rigid bodies, 6 ECTS in Mechanic of deformable bodies and 6 ECTS Machine elements.

**learning resources**

G. Simic, Rail vehicles- Constructions and calculations, Faculty of Mechanical Engineering 2013.
G. Simic, Instructions for writing student papers, hand-out
For preparation tasks as a basis should be used the appropriate regulations and standards

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 11
laboratory exercises: 0
calculation tasks: 0
seminar works: 3
project design: 8
consultations: 3
discussion and workshop: 5
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 1
check and assessment of projects: 5
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 5
project design: 30
final exam: 35
requirements to take the exam (number of points): 40
references

G. Simic, Rail vehicles- Constructions and calculations, Faculty of Mechanical Engineering 2013.
Ship resistance

ID: MSc-0955
responsible/holder professor: Simić P. Aleksandar
teaching professor/s: Simić P. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: naval systems
semester.position: 1.1

goals

The aims of the course are to familiarize students with: 1) fundamentals of ship hydrodynamics; how elementary ship form parameters affect ship resistance; 2) how to determine resistance for conventional ships types by applying standard engineering methods and by analyzing the results of model tests; 3) unconventional types/forms of ships from the aspect of ship resistance (shallow draught river vessels, planing and semi-displacement high speed craft, etc.).

learning outcomes

1) Basic knowledge about ship hydrodynamics needed for the design of conventional types of ships.
2) Ability to do calculations of ship resistance at the common engineering practice level.
3) Knowledge about basics of model tests and extrapolation of results from model to ship scale.
4) Basic knowledge about unconventional ship types and their forms.

theoretical teaching

To determine the ship’s main engine power, ship resistance must be determined first. It can be obtained by model tests or by other evaluation methods. Teaching is primarily oriented to practical application of ship hydrodynamics in common engineering practice. Attention is particularly focused on model tests that are still the most reliable tool as well as on the extrapolation of results from a model to a ship. Theoretical teaching is realized through the following teaching units: a) calculations of ship resistance components, resistance evaluation according to ITTC recommendations/method, b) effects of shallow and restricted water, c) model tests, model-ship correlation, standard methodical and statistical series, d) recommendations for design of ship forms, and e) high-speed (unconventional) craft.

practical teaching

The student should evaluate resistance for a usual sea-going ship (form) he/she was acquainted within the subject Buoyancy and stability of ship 1; obtained results will be used in the project that should be done within Ship propulsion course. Thus, the student is enabled to perceive the ship as a whole, and resistance itself as a part of applied ship hydrodynamics that is unavoidable in the ship design process. Within the framework of practical teaching the student is trained to do calculations using a computer i.e. to develop and apply a mathematical model for resistance evaluation by himself. Moreover, some teaching units presented by theoretical teaching involve calculation examples too.

prerequisite
Exams passed in Fluid mechanics and Buoyancy and stability of ship 1

**learning resources**

Lectures are available in electronic form
A detailed prominent example of the project
Internet resources

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 8
laboratory exercises: 0
calculation tasks: 9
seminar works: 0
project design: 8
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 10
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 60
requirements to take the exam (number of points): 20

**references**
M. Hofman and D. Radojcic, Resistance and propulsion of High Speed Crafts in Shallow Water, MF Belgrade, (in serbian)
Software Tools in Design in Mechanical Engineering

ID: MSc-0963
responsible/holder professor: Miloš V. Marko
teaching professor/s: Miloš V. Marko
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: seminar works
parent department: general machine design
semester.position: 1.1

goals

The main objective of this course is to achieve basic competence in the process of generating of technical systems and innovation, as well as introduction of basic academic knowledge of the capabilities and use of specialized software applied in three stages in the product development (design, elaboration of technological processes and the production).

learning outcomes

Students will acquire knowledge, tools and practical skills in the application of specialized software for the design and construction (engineering design) as well as programs that enable communication between various software for different purposes.

theoretical teaching

Basic definitions provided in mechanical engineering design. The notion of a technical system. The concept of technical innovation. Creation of technical systems and innovation. Basic capabilities of CATIA software (3D models and from them derived two-dimensional drawings and plans, linking them with additional modules for the kinematic calculations, FEM calculations and NC-programming).
Processing of 3D geometry imported into CATIA software from 3D scanners; translating from .stl format to .igs or .stp records suitable for improving the geometry and FEM analysis.
Basic design methods in the program SolidWorks.
Interface programs that enable communication between the software for different purposes, and their interconnection.
Linking programs CATIA and SolidWorks programs for the implementation of the finite element method Ansys and Abaqus; process optimization design.
Methods of computer analysis and optimization of the product; parametric optimization of three-dimensional structural elements (Goal Driven Optimization in Ansys) and structural optimization (using Altair HyperShape).
DELMIA software package; virtual planning, defining, monitoring and controlling production processes necessary to transform a computer model to a real mechanical products.

practical teaching

Examples of the application of software tools in the processes of the designing products used in the motor vehicle industry, shipbuilding, mechanical engineering, machinery, aviation,...
Practical exercise on a 3D printer.
Demonstration exercise of the NC machine.

prerequisite
None

**learning resources**

Moodle (Modular Object-Oriented Dynamic Learning Environment, open-source PHP web application for producing modular internet-based courses that support a modern social constructionist pedagogy).

Lectures, power point presentations, romm equipped with computers & software for design and simulations, 3D printer (Laboratory for Hybrid Technical Systems), NC machine, handouts.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 5
calculation tasks: 0
seminar works: 12
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 13
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 15
calculation tasks: 0
seminar works: 45
project design: 0
final exam: 30
requirements to take the exam (number of points): 45

**references**
User's Manual(s)
Spectroscopic methods and techniques

ID: MSc-1008
responsible/holder professor: Matija R. Lidija
teaching professor/s: Matija R. Lidija
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: control engineering
semester.position: 1.1

goals

Introducing students to fundamentals of spectroscopic methods and techniques. Through theoretical lectures and practical work student masters the understanding of light-matter interaction and how this interaction can be used to acquire information about structure of the matter. Through practical work on in the laboratory and analysis of spectral data student learns to apply acquired knowledge about structure of the matter in order to improve and control quality of various products in food industry, pharmacy, and other industrial branches, as well as perform characterization of new materials, biomaterials and biological samples with the purpose of applications in biomedical engineering for early detection of biomarkers, pathological changes and diseases.

learning outcomes

Upon successful completion of this course, students will be able to:

• Use different measurement instruments and methods of UV-Vis / NIR and FTIR spectroscopy
• Work in the laboratory and perform characterization of materials using appropriately selected spectroscopic methods
• Determine composition, as well as the chemical and physical properties of the tested materials Perform multivariate spectral analysis using computer software packages
• Calculate the ratios of components of interest in the samples, based on the spectra of samples
• Carry out the selection of spectral variables of interest for the given problem and define the inputs and outputs for diagnostic system

theoretical teaching

practical teaching

1. Practical work using UV/Vis/NIR spectrometer Lambda 950:
   1.1. Preparation of artificial food dyes solutions in water and determination of dye color on the basis of absorption peaks in visible region
   1.2. Determination of protection factor of sunglasses on the basis of glass absorption in UV region

2. Practical work using FTIR imaging system Spotlight 400 (Perkin Elmer) using ATR mode:
   2.1. Preparation of samples of 2 unknown pharmacological substances and spectral acquisition with the purpose of their identification. Identification of unknown substances using spectral database and concluding whether they belong to the class of doping drugs.
   2.2. Preparation of aqueous glucose solutions with varying concentrations; acquisition of spectra and determination of the presence of glucose based on its absorption peaks in fingerprint region. Preparation of sodium chloride aqueous solutions, spectral acquisition and comparison with the spectra of aqueous glucose solutions.
   2.3. In vitro spectral acquisition of blood and identification of the compounds visible in infrared region.

3. Practical work using FTIR Spotlight 400 imaging system – imaging mode
   Demonstration of microspectroscopic analysis of cervical cytological smears belonging to different PAP groups. Acquisitions of hyperspectral images and identification of healthy and cancer cells based on their spectra.

4. Practical work using NIR minispectrometer Hamamatsu, Japan.
   4.1. Acquisition of spectra of aqueous glucose solutions in NIR region.
   4.2. Demonstration of preprocessing techniques and regression analysis for determination of glucose concentration.
   4.3. Construction of aquagram and determining of glucose influence on hydrogen bonds in water.

prerequisite

Defined by the curriculum of the study module Biomedical engineering.

learning resources

1. Written course material (handout)
2. Scientific articles (KOBSON) - University network is available on laboratory computers (Nanolab) and cabinet 300
3. MATLAB, The Unscrambler, Pirouette, SPSS, Origin - sofwareas available in full or trial version
4. VIS-NIR, NIR Hamamatsu spectrometers (Hamamatsu, Japan)- -Nanolab
5. FT-IR imaging system-microscope and spectrometer (Perkin Elmer)-Nanolab
6 UV/Vis/NIR spectrometer Lambda 950 (Perkin Elmer, USA) - Nanolab

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30
active teaching (practical)

auditory exercises: 10
laboratory exercises: 18
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 4
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 8
final exam: 3

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 40

references

Steam Boilers elements and equipments

ID: MSc-1052
responsible/holder professor: Tucaković R. Dragan
Teaching professor/s: Stupar M. Goran, Tucaković R. Dragan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: thermal science engineering
semester.position: 1.1

goals

Reaching the competence and academic skills and methods for it's acquiring. Developing creative capabilities and mastering the specific practical skills. Goals determine the specific results which should be achieved within the subject. Goals also represent basis for control of the achieved results. Activities in this subject are in accordance with basic tasks and goals of the study program.

learning outcomes

After successfully completing the course, the students will be able to:
• Calculate the material balance of the combustion process of solid fuels.
• Choose the excess air and calculate the enthalpies of combustion products.
• Choose the system of temperature control of a superheated vapor.
• Select the fuel bed combustion systems.
• Perform the preliminary thermal boiler calculation.
• Get to know more about the plant by visiting the thermal power plant.

theoretical teaching

Introduction; Solid fuels; Combustion material balance; Determination of excess air; Regulating the temperature of superheated steam - (Inherent regulation; Flue gas regulation; Steam regulation); Regulating the temperature of reheated steam; Apparatus for combustion of the opposite scheme - flat grate stoker; Apparatus for combustion of the cross scheme - chain and inclined grate stoker; Coal dust preparation systems; Devices for storage and transportation of coal; Mill constructions; Coal dust separators; Coal dust classifiers; Coal dust burners

practical teaching

Auditory exercises consist of demonstration exercises (Classification and construction of steam boilers with appropriate heating surfaces, auxiliary devices and equipment); Steam boiler heat balance; Working project - Working principle of industrial steam boilers; Determining the losses, efficiency and fuel consumption of the given steam boiler; Furnace dimensioning; Heat and material balance of steam boiler heating surfaces; Making of the boiler draft.

prerequisite

Necessary condition: Bachelor’s degree ;
Preferred passed exam: steam boiler basics
learning resources

Books: Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers, Faculty of Mechanical Engineering, Belgrade, 2010, (In Serbian); Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers Thermal Calculation, Faculty of Mechanical Engineering, Belgrade, 2010, (In Serbian); handouts which will be at student's disposal a week in advance

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 12
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 8
consultations: 0
discussion and workshop: 10
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 4
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 40
requirements to take the exam (number of points): 30

references
Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers, Faculty of Mechanical Engineering, Belgrade, (In Serbian)
Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers Thermal Calculation, Faculty of Mechanical Engineering, Belgrade, (In Serbian)
Steam Turbines 1

ID: MSc-0274
**responsible/holder professor:** Petrović V. Milan
**teaching professor/s:** Petrović V. Milan
**level of studies:** M.Sc. (graduate) academic studies
**ECTS credits:** 6
**final exam:** written+oral
**parent department:** thermal power engineering
**semester.position:** 1.1

goals

1. The achievement of academic competence in the field of steam turbines and thermal power engineering.
2. The achievement of theoretical knowledge about how to transform heat into mechanical work learning thermodynamic processes and equipment (steam turbine and steam turbine power plants).
3. The acquisition of practical knowledge to optimize thermodynamic cycle and steam turbines.
4. The achievement of the techniques of process modeling.
5. Mastering the methods of experimental work in thermal power engineering.

learning outcomes

On completion of this programme, it is expected that student will be able to:
- identify the thermodynamic cycle parameters affecting the quality of the installation and optimization of thermodynamic cycle steam turbine,
- perform calculation of of the heat balance diagram, the steam expansion process in the turbine, the process in the condenser and feedwater heater,
- determine the main thermodynamic parameters of steam power plant that define the quality of plant operation
- set the control boundary and make the balance of the turbine plant and the whole power plant according to the first and second law of thermodynamics,
- perform calculation of main gasodynamic parameters (row efficienceny, loss coefficient , deviation and exit flow angle) of the steam turrbine cascade based on geometric and operating parameters
- apply one-dimensional theory of compressible fluid flow in the one-dimensional turbine stage design,
- identify and select stage between action and reaction type,
- professional and accurately communicate using the terminology of the respective product areas.

theoretical teaching

Theoretical teaching is carried out through 10 teaching modules:
1) Thermodynamic background of the steam turbines and steam turbine cycles. Thermodynamic improvements, increase of live steam temperature and pressure, condensation, and decrease of the condensation pressure.
2) Reheat. Regenerative feed water heating. The basic thermodynamic cycles and heat balance diagrams.
3) Steam turbine power plant -the 1st and 2nd law of thermodynamics.
4) The fluid dynamics background of steam turbines, gas-dynamic processes in steam turbines.
5) Cascades of the steam turbine. Geometry and operating parameters. The main gas-dynamic parameters of the steam turbines cascades.
6) The aerodynamic losses in the cascades.
7) 1D theory of elementary stages of steam turbines. Euler equation for the turbine. Efficiency of the stage.
8) Axial elementary impuls stage.
9) Axial elementary reaction stage of Parsons type.
10) Internal efficiency of the stage. Internal losses. Determination of main dimensions of stage.

**practical teaching**

Practical teaching is carried out through:
Auditory exercises: basic principles. Historical development. Classification and application of steam turbines. Explanation of the heat balance diagrams and the functioning of components of the steam turbine plants. Instructions for calculation of the heat balance diagram and the main thermodynamic parameters of the steam turbine plants. Instruction to create an energy and exergy balance of the steam turbine plant according to the 1st and the 2nd law of thermodynamics.
Labs: Experimental determination of the specific steam consumption of steam turbines at the Laboratory of Mechanical Engineering.
Project design: Calculation of the heat balance diagram, the main thermodynamic parameters and the balance of the steam turbine plant.

**prerequisite**

Passed exams in Thermodynamics and Fluid mechanics

**learning resources**

Vasiljevic, N.: Steam turbines Faculty of Mechanical engineering, Belgarde, 1987.
Petrovic, M.: Instruction for steam turbine projet, Belgrade, 2004
Petrovic, M.: Scripts and handouts for Steam turbines
Instructions for performing laboratory exercises
Software package for calculating of properties of steam and water.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 9
laboratory exercises: 4
calculation tasks: 0
seminar works: 0
project design: 13  
consultations: 4  
discussion and workshop: 0  
research: 0  

knowledge checks  
check and assessment of calculation tasks: 0  
check and assessment of lab reports: 1  
check and assessment of seminar works: 0  
check and assessment of projects: 7  
colloquium, with assessment: 2  
test, with assessment: 0  
final exam: 5  

assessment of knowledge (maximum number of points - 100)  
feedback during course study: 5  
test/colloquium: 10  
laboratory exercises: 5  
calculation tasks: 0  
seminar works: 0  
project design: 30  
final exam: 50  
requirements to take the exam (number of points): 25  

references  

Stojanovic, Themal Turbomachinery, Gradjevinska knjiga, Belgrade, 1967. 
Technological processes in agro complex

ID: MSc-0560
responsible/holder professor: Marković D. Dragan
Teaching professor/s: Simonović D. Vojislav
Level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
Final exam: written
Parent department: agricultural engineering
Semester.position: 1.1

Goals

1. Obtaining knowledge through a multidisciplinary approach that can be considered rational, optimizing technical processes. 2. Mastery of processes in agricultural production through the knowledge of the type and condition of soil and agricultural materials. 3. Acquisition of practical skills for working in the field of new technologies in agriculture and in agricultural machinery.

Learning outcomes

After successful completion of this course, studenty should be able to:

- Design a complete mechanical system for mechanization of agricultural production of certain plant species,
- Organize the optimal exploitation of agricultural machines and systems,
- Manage the maintenance of agricultural machines and systems,
- Identify, formulate, analyze and solve engineering problems,
- Be efficient in teamwork,
- Communicate effectively in a multidisciplinary environment, with users and producers.

Theoretical teaching


Practical teaching

1. Auditory exercises: Showing the determination of moisture agricultural materials-soil, plants and yields. Technological maps - making. Establishing criteria for the selection of agricultural requirements. The technological technical systems of tillage, fertilization, seeding, planting, watering and maintenance of the crops. 2. Laboratory Exercise: Determination of the coefficient of friction of soil on the desktop of agricultural machinery.
3. Production of the paper: Seminar on the protection of the soil, fertilization, irrigation, seeding and planting and sorting of agricultural crops. Consultations 4. Consultations are used to refer students in the preparation of the paper to help students in choosing literature and other consultations on teaching.

**prerequisite**

VII semester from Mechanical faculty and from FTN's, as well students from the department of mechanization from Agriculture Faculty of BG or NS.

**learning resources**

2. Determining the coefficient of friction.
3. Lectures in electronic form.
4. Instructions for the preparation of the paper.
5. Renowned copy of the paper.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 3
calculation tasks: 0
seminar works: 8
project design: 0
consultations: 2
discussion and workshop: 2
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 2
check and assessment of seminar works: 6
check and assessment of projects: 0
colloquium, with assessment: 2
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 40
requirements to take the exam (number of points): 50

references

Konstantinović J., Soil tillage in crop production, the Institute of Field Novi Sad, 1997.
Various authors, Modern agricultural techniques in crop production, monographs, PF, Belgrade, 1997.
**Theory of Turbomachinery**

**ID:** MSc-1000  
**responsible/holder professor:** Ilić B. Dejan  
**teaching professor/s:** Ilić B. Dejan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** hydropower engineering  
**semester.position:** 1.1

**goals**

Introduction of theoretical knowledge of fluid flow in turbomachinery. Studying of energy and exploitation characteristics of turbomachinery in dimensional and non-dimensional forms and their application in mechanical systems. Obtaining of practical skills application of hydraulic turbines, pumps, fans and turbocompressors in power systems.

**learning outcomes**

On successful completion of this course, students should be able to:
1. Identify and describe the different types and designs of turbomachinery (hydraulic turbines, pumps, fans and turbocompressors),
2. Explain the flow process and exchange of energy in turbomachinery,
3. Identify and analyze energy and exploitation characteristics of turbomachinery,
4. Explain the cavitation phenomenon in pumps and hydraulic turbines.

**theoretical teaching**

- Description, classification, and the working principle of turbomachinery.
- The principles of energy exchange and energy balance in turbomachinery. Phenomena in fluid flow in turbomachinery.
- The theoretical basis of thermodynamic. Multi-stage compression in the compressors (work and efficiencies).
- Definition of the internal work and impeller work. Euler equation for turbomachinery. Specific hydraulic energy.
- The impact of the impeller outlet angle on the impeller head and on the reaction factor.
- Impeller head reduction - the impact of a finite number of blades.
- Powers and efficiencies of pumps. Losses in turbomachinery.
- The laws of similarity. Characteristic coefficients of turbomachinery.
- Control of turbomachinery.
- Hydro (aero) profiles. Method of lifting surfaces.

**practical teaching**

prerequisite

Compulsory examinations passed: Fluid Mechanics, Thermodynamics.
Preferred exams passed: Basis of Turbomachinery, Pumps and Fans.

learning resources

Lectures in written and partially in electronic form, handouts for the exercises.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 20
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 10
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

references
Transport phenomena in process industry

ID: MSc-1056
responsible(holder) professor: Stamenić S. Mirjana
Teaching professor(s): Stamenić S. Mirjana
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: process and environmental protection engineering
semester.position: 1.1

goals

Acquiring the necessary knowledge to understand the transport phenomena of heat and mass transfer in the process industry. Application of steady and unsteady heat and mass transfer in phases (two or more component fluids) in process equipment.

learning outcomes

The understanding of fundamentals of heat and mass transfer processes accompanied with multi-phase fluid flow. Estimation procedures for the intensity of heat and mass transport and pressure drop in chemical engineering.

theoretical teaching

Steady and unsteady state heat and mass transfer in fluids.
Differential equations of momentum, heat and mass convective transport. Laminar and turbulent flow.
Similarity theory. Analogies between mass, heat and momentum transfer.
Mass transfer across a phase boundary. Inter-phase turbulence.
Simultaneous mass and heat transfer. Wet-bulb temperatures.
Boiling, condensation and thermal radiation. Typical cases in process equipment (heat exchangers, columns, furnaces).
Unsteady heat and mass transfer in solid phase.
Heat radiation.

practical teaching

Examples of steady and unsteady state molecular transport in fluids and solids
Examples of convective transfer.
Examples of application of the similarity theory - criterial equations
Examples of heat and mass transfer across a phase boundary.
Examples of simultaneous heat and mass transfer.
Laboratory: Wet-bulb temperature, coefficient of molecular diffusion
Examples of heat transfer with phase change: boiling, condensation
Examples of thermal radiation.
Examples of the unsteady heat and mass transfer in solid phase.
Examples of heat radiation.
prerequisite

Defined in curriculum of the module

learning resources

Resources are books listed within chapter - Literature

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 22

active teaching (practical)

auditory exercises: 17
laboratory exercises: 5
calculation tasks: 10
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 2
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 10
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 5
calculation tasks: 15
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 31

references
Vehicle Design

**ID:** MSc-1140  
**responsible/holder professor:** Rakićević B. Branislav  
**teaching professor/s:** Blagojević A. Ivan, Mitić R. Saša, Rakićević B. Branislav  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** motor vehicles  
**semester.position:** 1.1

**goals**

The objective of the course is to develop the logic of designing the systems and components that make up the vehicle, on the basis of the necessary requirements that it must fulfill. In addition, interconnecting the systems into the functional unity - a vehicle - is a skill that a student should also master.

**learning outcomes**

Upon successful completion of this course, students should be able to: Identify all the necessary requirements that the system should fulfill at the design and exploitation stage; Analyze the existing solutions of systems and components of the vehicle for use on another vehicle; Determine the loads which act on vehicle components; Apply the acquired logic through the independent design project.

**theoretical teaching**

Introductory lectures refer to the vehicle layout, followed by units dealing with clutch, gearbox, transmission driveline, braking system, steering system and suspension system, and also with vehicle ergonomics. Each of the units implies explanations for: initial requirements and parameters on the basis of which the element is designed; adopting the appropriate layout; reviewing existing solutions; identification of appropriate elements of the system or assembly and their positioning and dimensioning; analyzing the basic loads to which the component is exposed.

**practical teaching**

Practical classes are conducted through independent project for each of the listed units (clutch, gearbox, transmission driveline, braking system, steering system, suspension system and vehicle ergonomics). In the development of this project, students can use available showpieces of vehicles, systems and components.

**prerequisite**

No special requirements.

**learning resources**

N. Janićijević, D. Janković, J. Todorović: Motor Vehicle Design (in Serbian), University of Belgrade, Faculty of Mechanical Engineering.

**number of hours**

Faculty of Mechanical engineering — course catalog — M.Sc. (graduate) academic studies  
70
total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 15
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 30
requirements to take the exam (number of points): 35

**references**

N. Janićijević, D. Janković, J. Todorović: Motor Vehicle Design (in Serbian), University of Belgrade, Faculty of Mechanical Engineering.
B. Rakićević, I. Blagojević, S. Mitić - Vehicle Design lecture handouts
-


**Engine Working Processes**

**ID:** MSc-0852  
**responsible/holder professor:** Popović J. Slobodan  
**teaching professor/s:** Popović J. Slobodan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** internal combustion engines  
**semester.position:** 1.1

**goals**

The aims of the course are: Gaining basic theoretical and practical knowledge about physicality of real engine working processes. Making a complete spark ignition and diesel engine working cycle calculation. Analysis of engine working process integral working parameters and operating characteristics.

**learning outcomes**

Merging a theoretical knowledge of thermodynamics and fluid mechanics, connecting and application on real object – internal combustion engine.  
Training for basic modeling and calculating of real engine working process, as well as acquiring fundamentals of engine designing.  
Mastering of engine working parameters and operating characteristics and of the influences of working process on operating, energetic and ecologic engine characteristics.

**theoretical teaching**

1. Analysis of thermodynamic ideal cycles. Engine real working cycle; fundamentals of cycle modeling.  
2. Gas exchange process; gas flow through the channels and valves. Gas exchange in 4-stroke engines; valve timing; indicators of gas exchange process quality. Gas exchange in 2-stroke engines. Compression process.  
3. Combustion in spark ignition engine; phases, influencing factors and process calculation.  
6. Engine operating characteristics: speed and load characteristics, propeller and universal characteristics.

**practical teaching**

1. Analysis of thermodynamic ideal cycles; numerical examples of engine ideal thermodynamic cycles.  
3. Display of various spark ignition engines combustion chambers and their comparison. Display of various diesel engines combustion chambers and their comparison.  
prerequisite

No prerequisites required.

learning resources

4. Test bench for internal combustion engines testing, Department of IC engines
6. National Instruments LabView 7.1 (PPO)

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 12
laboratory exercises: 0
calculation tasks: 5
seminar works: 0
project design: 9
consultations: 4
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 2
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 3
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 15
laboratory exercises: 0
calculation tasks: 15
seminar works: 0
project design: 30
final exam: 40
requirements to take the exam (number of points): 0

references

Orlin A. S., Kruglov M. G., i dr., Teorija rabočih procesov poršnevih i kombinirovanih
Automatic Control

ID: MSc-0286

responsible/holder professor: Lazić V. Dragan

teaching professor/s: Lazić V. Dragan

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: written+oral

parent department: control engineering

semester.position: 1.2

goals

• to provide theoretical basis, proofs of theorems and more detailed definitions than in the basic course (Introduction of Automatic Control) to get students familiar with the area and therefore fully understand the essence of matter.
• to include all the issues which usually listens worldwide at a course of control
• to enable students to follow the following subjects in this Department

learning outcomes

• The acquisition of wider knowledge of the automatic control, as a technical field that requires a modern engineer
• identify and use the methods needed for analysis and synthesis of controllers in the control systems, and the entire control systems
• the implementation of computers and MATLAB and address the underlying problems of the automatic control, as well as other engineering problems
• the analytical and / or experimental investigation of the basic dynamic and static characteristics of the systems

theoretical teaching


practical teaching

Practical training shall include the computational tasks which illustrates the exposed material given by the definitions or by any theorem. Connecting different types of mathematical models of linear systems: differential equations, equations of the state and the output equations, transfer functions and block diagram of the system - the transition from one form to another model. Simulation results for the illustration the above definitions and theorems are done on personal computers using MATLAB. In this subject much more tools, commands, scripts, ... from MATLAB will be used, as compared to those obtained in the subject Introduction of Automatic Control.
prerequisite

Passed course Introduction of Automatic Control and nothing more

learning resources

- Script on website: http://au.mas.bg.ac.rs/Nastava-Kau/Nastava_Download.htm
- Licensed Software in the possession of the Faculties.
- Freeware software.
- PCs.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 12
labatory exercises: 18
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 4
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 50
laboratory exercises: 5
calculation tasks: 10
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references
Ljubomir Grujic, Dragan Lazic, "AUTOMATIC CONTROL", Script, Faculty of Mechanical Eng., 2007
Biomedical instrumentation and equipment

ID: MSc-0287
responsible/holder professor: Lukić M. Petar
teaching professor/s: Lukić M. Petar, Stojić M. Tomislav
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: physics and electrical engineering
semester.position: 1.2

goals

Introducing to standard measuring and diagnostically medical methods and implementation of electron devices in medicine. The focus is on the principles and operation methods of the biomedical equipment with brief description of device construction. The subject educates engineers to improve still existing and develop new biomedical equipment.

learning outcomes

By attending the course, students will be educated to understand and analyze problems concerned with operation and usage of biomedical instrumentation and equipment. This course educate students to connect basic principals of electronics, physics and medicine and to practically implement them into modern medical equipment.

theoretical teaching


practical teaching


prerequisite

Electrical engineering and Electronics
Electronics and biomedical measurements

learning resources


[5] Handouts

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 25
laboratory exercises: 0
calculation tasks: 0
seminar works: 3
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 3
check and assessment of projects: 0
colloquium, with assessment: 3
test, with assessment: 4
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 15
test/colloquium: 35
laboratory exercises: 0
calculation tasks: 0
seminar works: 15
project design: 0
final exam: 35
requirements to take the exam (number of points): 35

**references**
Computer Aided Design in Material Handling Practice

**ID:** MSc-0909  
**responsible/holder professor:** Gašić M. Vlada  
**teaching professor/s:** Gašić M. Vlada  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** material handling, constructios and logistics  
**semester.position:** 1.2

**goals**

Basic goals of this course are: 1) introduction to finite element method and applications in design of structures for material handling machines, 2) gaining the practical skills for 2D and 3D design and modeling of structures of material handling machines.

**learning outcomes**

After the completion of the course, student is trained to:  
- Apply the finite element method (FEM), with linear finite elements, in formulation and calculation of plane trusses and frames  
- Perform static analysis of plane truss and frame in FEM software and work and present basic technical report for given engineering problem  
- Form the 3D structural model with linear finite elements and give static analysis due to loads  
- Use different FEM software for structural analysis  
- Do the basic design of gantry crane according to engineering recommendations

**theoretical teaching**


**practical teaching**

Matrix method for calculation of displacements, internal forces and stresses in 2D truss system with 5 nodes. Matrix method for calculation of displacement and internal forces at plane two beam-elements model. Modeling the characteristic structures for material handling machines, in finite element software (trusses, beams, frames, cranes). Preparation for input data and analysis of output data. 3D modeling in given software of some parts of material handling machines.

**prerequisite**

Necessary: Mathematics 2, Strength of materials  

**learning resources**

1. Computer room 516
2. FEA softwares

**Number of hours**

total number of hours: 75

**Active teaching (theoretical)**

lectures: 30

**Active teaching (practical)**
auditory exercises: 10
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**Knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 8
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 2
test, with assessment: 0
final exam: 5

**Assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 15
laboratory exercises: 45
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

**References**

Handouts with examples
**Continuum Mechanics**

**ID:** MSc-0826  
**responsible/holder professor:** Stokić M. Zoran  
**teaching professor/s:** Zorić D. Nemanja, Stokić M. Zoran  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** mechanics  
**semester.position:** 1.2

**goals**

To introduce students continuum mechanics as applied form of classical mechanics. Aim of this subject is to students overcome and understand terms of continuum mechanics, i.e., to familiarize basic principles Euler’s and Lagrange’s approach to continuum, as well as basic of tensor calculus.

**learning outcomes**

Upon successful completion of this course, students should be able to:  
- form Green (Lagrangian) strain tensor;  
- form Eulerian strain tensor;  
- form velocity strain tensor;  
- determine the stress tensor components;  
- compose general equation of motion (Navia) of any deformable medium;  
- form continuity equation (conservation of mass);  
- apply the theorem of the change in total energy of a continuous medium in integral form.

**theoretical teaching**


**practical teaching**


**prerequisite**

Defined by curriculum.

**learning resources**
Handouts

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 10
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 60
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 0

**references**

I. S. Sokolnikoff, Tensor Analysis, Willey, 1951.
Design of Welded Structures

ID: MSc-0898
responsible/holder professor: Radaković J. Zoran
teaching professor/s: Radaković J. Zoran
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: engineering materials and welding, tribology, fuels and combustion
semester.position: 1.2

goals

After having completed the course, along with the theory and practical classes (through problems and calculation exersizes, seminars etc.), the student acquires the proper academic knowledge and skills in the field of weld design, and stress state analysis of the welded structure. The welded structures of interest are made of steel and aluminium alloys. In addition to the static calculation and design of welded structures, other fields of design include cases of fatigue loading, as well as dynamic loads. Particular design cases also include modern methods in evaluating the residual stresses and strains. Candidates shall be familiar with, and be able to apply their knowledge to real welded structures in exploitation. They should be familiar with modern scientific papers in the field, and are able to fully understand and keep track of scientific articles.

learning outcomes

Upon the successful completion of the course, the students are able to:
• Identify the loading types of welded structures
• Analyze the stress state of the welded structure (also with the presence of complex loads)
• Solve specific problems of calculating welded structures with both fillet and butt welded joints
• Solve complex stress states, that evolve from a combination of different loading types (tension, bending, shear, torsion, restrained torsion) in both static and dynamic conditions
• Solve problems in the calculation of fatigue loaded welded structures
• Solve problems in the calculation of dynamically loaded (impact) welded structures
• Solve problems in the calculation of welded structures with characteristic member sections
  – light-weight structures with thin cross sections, both open- and closed profile contour sections
• Solve the implications that may arise in cases of poor design, or as a result of material structural damage
• Connect the acquired knowledge from this field to the knowledge from other fields: engineering materials, mechanics, strength of materials, structural resistance, metal structures, welding technology, with applications in practice

theoretical teaching

practical teaching


prerequisite


learning resources

1. Z. Petkovic, D. Ostric, Metallic Structures in the Machine Building Industry 1, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, 1996 (or later). (in Serbian)
2. Z. Perovic, Welded Structures, University of Montenegro, Faculty of Mechanical Engineering, Podgorica, 2002 (or later) (in Serbian)
3. D. Ruzic, Strength of Structures, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, 1996. (in Serbian)
5. Scripts/handouts from class lectures and exercises, and presentations in electronic format.
6. Internet resources.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 10
seminar works: 10
project design: 0
consultations: 5
discussion and workshop: 5
research: 0

knowledge checks

check and assessment of calculation tasks: 5
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 2
final exam: 3

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 15
seminar works: 10
project design: 0
final exam: 40
requirements to take the exam (number of points): 40

references

Z. Perović, Zavarene konstrukcije, izd. Univerzitet Crne Gore, Mašinski fakultet, Podgorica, 2002
goals

First step include descriptive statistics. Next step is to identify problem to be solved, followed by choose of adequate methodology and solving problem using procedure appropriate procedure, following by mathematical and engineering conclusions. Engineering conclusions are the base for results interpretation and withdrawing adequate conclusions.

learning outcomes

After successfully completed course, students should be able to define the problem, identify and apply adequate statistical procedures and obtain competent answers. During the course students master the procedures for use of adequate parametric and non-parametric methods as well as introduction in programming in R. It is expected that students could be able for interpretation of statistical results for their use in practical problems.

theoretical teaching

Course include following subjects: Basic definitions in statistics; Descriptive statistics; Basics of discrete and continuous probability distributions for random variables; Parameter tests of hypothesis that include one and two sample tests for means, proportion and variance. Non-parametric testing include goodness of fit by Kolmogorov test, comparison tests for distributions such as Mann Whitney test, Kolmogorov-Smirnov test and tests for median and difference of median; One-way and two-way analysis of variance for parametric examination; Non-parametric analysis of variance, Simple linear and multiple regression and correlation for parametric testing and Spearman test and Orthogonal polynomials as an examples of non-parametric regression and correlation examination.

practical teaching

Exercises follow the contents of lectures by examples and problem solving in order to identify and set the problem adequately, followed by identification of appropriate statistical method and procedure up to interpretation of the results and drawing the conclusions. For all methods is required adequate R programming. Exercises are based on examples that teach students to use specially developed tables for procedures algorithms and tables with formulas for better and efficient problem solving. Proper practical interpretation of results and drawing of conclusions is emphases.

prerequisite

According the Industrial Engineering curriculum

learning resources
All materials for successful following of the course - handouts and other materials are distributed to students before lectures in electronic form.

Radojević S, Veljković Z, Kvantitativne metode, CD. MF

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 25

**active teaching (practical)**

auditory exercises: 20
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 9
test, with assessment: 0
final exam: 1

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 40
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 31

**references**

Radojević S, Veljković Z, Kvantitativne metode, CD. MF
Flight Dynamics and Aerodynamic of Projectiles

ID: MSc-1084
responsible/holder professor: Todić N. Ivana
teaching professor/s: Todić N. Ivana
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: weapon systems
semester.position: 1.2

goals

Introduce students to the basics of calculations and modeling the dynamics of flight of the projectile. Introduce students to the basics of the structure and implementation of the program for the modeling of the dynamics of flight. The introduction of the experimental methods and analyses of flight tests. Introduce students to the basics of aerodynamic calculations. Introduce students to the basics of the structure and implementation of the program for calculations of aerodynamic of the projectile. Introduction to experimental methods in aerodynamics.

learning outcomes

Student is qualified for independent work on the calculations and flight dynamics modeling of guided and unguided projectiles. Student is qualified for experimental work in the field of flight testing. Student is qualified for independent work on the calculations of aerodynamic characteristics of guided and unguided projectiles. Student is qualified for experimental work in the field of aerodynamic tests.

theoretical teaching


practical teaching

Stability aerodynamically stabilized projectiles (assignments) Stability gyro-stabilized projectiles (examples) Maneuverability of guided missile (assignments) Fundamentals of projectile flight dynamics modeling (modeling packages 6DOF, MATLAB, Simulink).
Modeling unguided missiles (case modeling). Modeling guided missile (case modeling). The

**prerequisite**

none

**learning resources**

1. Blagojević Đ.: The dynamics of flight of the projectile, Belgrade, 2004;

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 25

**active teaching (practical)**

auditory exercises: 5
laboratory exercises: 5
calculation tasks: 10
seminar works: 0
project design: 15
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 25
final exam: 45
requirements to take the exam (number of points): 35

references

Industrial robots

**ID:** MSc-1106  
**responsible/holder professor:** Miljković Đ. Zoran  
**teaching professor/s:** Miljković Đ. Zoran, Slavković R. Nikola  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** production engineering  
**semester.position:** 1.2  

**goals**

The student should acquire fundamental knowledge of industrial robots (basic subsystems, their functioning variants and realization), knowledge needed for robot design, robotized workplaces design, robot programming as well as develop capability for further dealing with subject matter in domain of robotics.

**learning outcomes**

After completed this course the students should be able to:
- Understand the role and importance of industrial robots application (effects on productivity, flexibility, product quality and humanization of work).
- Solve the problem of robot introducing to the plant/factory.
- Select appropriate robot configuration, end-effector and peripheral equipment for given technological task.
- Design robotized workplace taking into account cycle time analysis as well as techno-economic analysis (pay back analysis).
- Programming the robots as well as robotized cell.
- Design the basic manipulator mechanical subsystems as well as select the appropriate components.

**theoretical teaching**


**practical teaching**

Practical teaching: 1. Five auditorial exercises: Kinematics of manipulators. Analysis of drive systems, measuring systems, transmission systems. End effectors. Robot programming. Robot application. 2. Four calculation tasks: Spatial relations and transformations. Robot kinematics and cycle time analysis. Three homeworks relates to all these areas. 3. Three laboratory

**prerequisite**

Study curriculum and student motivation for knowledge acquisition in domain of industrial robots according to the goals set and outcomes offered.

**learning resources**

2. D. Milutinović, Z. Miljković, N. Slavković, Handouts for each lecture. /In Serbian and English/
3. Z. Miljković, N. Slavković, Instructions for doing tasks, laboratory exercises and seminar work. /In Serbian and English/
4. Z. Miljković, N. Slavković, The Course site (http://cent.mas.bg.ac.rs/nastava/ir_msc/index.htm) containing relevant information for students, book references as well as addresses of robot manufacturers and respective institutions (IFR, RIA, JARA, CIRP, etc.).
10. Facility: Laboratory for industrial robotics and artificial intelligence with four industrial robots, ten mobile robots equipped with sensors and microcontrollers, four cameras, software for simulation and programming WORKSPACE 5, 3D printer as well as educational means.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 13
laboratory exercises: 8
calculation tasks: 8
seminar works: 1
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 3
check and assessment of lab reports: 0
check and assessment of seminar works: 1
check and assessment of projects: 0
colloquium, with assessment: 2
test, with assessment: 4
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 60
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**

Innovative Design of Technical Systems (Engineering Design Methodology)

ID: MSc-1094  
**responsible/holder professor:** Marinković B. Aleksandar  
**teaching professor/s:** Ognjanović B. Milosav  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** general machine design  
**semester.position:** 1.2

**goals**

To introduce the students with the procedure of synthesis (creation) of the principally new technical system, which starts with the idea to create the new TS to the project, which is the basis for its production, exploitation and recycling. Development of creative skills for engineering design and the development of the sense for the need and for the role of aesthetic design. Development of creative skills of the students for caring out the procedure of harmonizing of the properties (functional, technological and aesthetic) with the environment, living and operating environment. The main goal is to introduce students to scientific and technical aspects of creating of the structure of technical systems in terms of satisfying the necessary functions and behaviors in service and technology benefits for the production, maintenance and recycling.

**learning outcomes**

After successful completion of this course, students should be able to do the next:
1. The abstract thinking in an innovative creation (design) of technical systems;
2. Create the conceptual structure (the new principle of operation) technical system – Function-based Design;
3. To transform the conceptual design solution to embodiment design in accordance with the regulations, rules and environment;
4. To develop a form of components in accordance with the technological and economic constraints;
5. To develop design aesthetics in harmony with the environment and needs;
6. To develop innovative technical solutions based on the transformation of biological systems and to harmonize with the environment from an ecological point of view.

**theoretical teaching**


**practical teaching**
In the course of semester the students working out seminar work which that allows them to understand the purport of the technical system functions. The starting point is existing design solution and the inverse procedure application leads the students to the abstract structure of the functions which is the basis for the development of innovative i.e. to the new design solutions. Auditory exercises also contains analysis and discussions of issues and practical examples covered by theoretical classes with the aim to introduce students to the phenomena that need to process in their seminar works and to prepare for the tests.

**prerequisite**

no specific conditions

**learning resources**

1. Book-Tutorial: Ognjanović M: Innovative development of technical systems (Chapter 2: The innovative design of technical systems) - University of Belgrade, Faculty of Mechanical Engineering 2014th;
2. Examples with the solutions and the necessary data for the calculations are given in the book referred to in the point 1.;
3. Power-Point presentations, lectures available to students in the form of hand-out materials;
4. Laboratory for Design in Mechanical Engineering.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 16
seminar works: 6
project design: 0
consultations: 0
discussion and workshop: 8
research: 0

**knowledge checks**

check and assessment of calculation tasks: 2
check and assessment of lab reports: 0
check and assessment of seminar works: 2
check and assessment of projects: 0
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**
feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 20
seminar works: 10
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references

Pahl G., Beitz W.: Engineering Design - A systematic approach, - Springer Verlag;
Hubka V., Eder E.: Theory of Technical Systems, - Springer - Verlag;
Hubka V., Eder E.: Design Science, - Springer - Verlag
Haufe T: DESIGN, - DuMont Buchverlag;
Mechanical and hydromechanical Operations and Equipment

**ID:** MSc-0991  
**responsible/holder professor:** Obradović O. Marko  
**teaching professor/s:** Obradović O. Marko  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** process and environmental protection engineering  
**semester.position:** 1.2

**goals**

The objective of the course is to students get theoretical and practical knowledge of common mechanical and hydromechanical processes and the associated equipment utilized in mineral processing. Course acquaints the students with characteristics of bulk solid materials and the basics techniques for bulk solid characterization. Mechanisms and basic principles of size reduction are covered. Subject gives overview of the main unit operations with respect to comminution (crushing and grinding) and screening/classification met in nowadays practice as well as equipment used in the unit operations. The combination of unit operations and equipment into circuits is also covered, as well the calculation of the basics characteristics of the equipment used.

**learning outcomes**

After completing the course the students are expected to able to calculate and use the curves for particle size distribution. Students shall know the most important unit operations in mineral processing, the mechanisms and principles of size reduction and methods used to classify particles according to their size and their characteristics. Student will be able to identify and select the equipment involved in a comminution circuit and calculate basics characteristics of the equipment. The students should know the principles for designing mineral processing circuits.

After completing the course students will be capable to apply their knowledge in the real case studies of mineral processing and will have required background knowledge for mineral concentration processes.

**theoretical teaching**

practical teaching


prerequisite

Obligatory subject of elective module Process engineering and environment protection.

learning resources

3. Knežević Dinko: Mineral processing, University of Belgrade, Faculty of Mining and Geology, Belgrade, 2012.
4. Ćalić Nadežda: Principles of mineral processing, University of Belgrade, Faculty of Mining and Geology, Belgrade, 1990.
6. Laboratory installation for coal grindability testing and particle size distribution, Laboratory for Process Engineering

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 19
laboratory exercises: 2
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 9
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 3
check and assessment of seminar works: 0
check and assessment of projects: 3
colloquium, with assessment: 0
test, with assessment: 4
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 30
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 10
final exam: 50
requirements to take the exam (number of points): 28

**references**

***: Basics in Minerals Processing, Metso Corporation, 2015.
Mixture formation and combustion i IC engines

**ID:** MSc-1086  
**responsible/holder professor:** Popović J. Slobodan  
**teaching professor/s:** Popović J. Slobodan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** internal combustion engines  
**semester.position:** 1.2

**goals**

The aims of the course are to provide a comprehensive insight into the subject matter of Engine Fueling, Mixture formation and Ignition processes. Understanding the role, importance and principles of Engine Electronic Control. Broadening existing and acquiring new knowledge in hydrodynamics by studying high pressure phenomena occurring in fuel injection systems. Broadening knowledge in machine design by studying specific issues of high pressure pumps design principles. Broadening knowledge in electromechanics and electronics by studying processes occurring in Ignition Systems. Introduction into the field of Engine Sensors, Electronics and Mechatronics.

**learning outcomes**

Capabilities to develop, design, calculate and chose components of Engine Fueling and Ignition Systems. Capabilities to develop and organize maintenance procedures for both Fueling and Ignition Systems. Abilities related to specific issues of laboratory testing of Fueling and Ignition Systems and components. Developing practical skills for System set up and diagnostics.

**theoretical teaching**


**practical teaching**


**prerequisite**

Desirable: Good practical knowledge of Matlab/Simulink

**learning resources**

2. M. Tomić, S. Popović: Extracts from Lectures (handouts), available in digital form
3. IC Engine testing Laboratory (with an engine on the test bed)
4. Flow Test Bench (in accordance to ISO 5167)
5. Diesel Injection System test Bench
7. National Instruments LabView

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 11
laboratory exercises: 14
calculation tasks: 4
seminar works: 0
project design: 0
consultations: 1
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 4
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 6
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 25
laboratory exercises: 35
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

references

Object oriented paradigm

**ID:** MSc-0527  
**responsible/holder professor:** Radojević LJ. Slobodan  
**teaching professor/s:** Bengin Č. Aleksandar, Vorotović S. Goran, Mitrović B. Časlav  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** project design  
**parent department:** information technologies  
**semester.position:** 1.2

**goals**

- Introduction to OOP paradigm.  
- Purposeful use of classes, objects, inheritance, encapsulates, methods and hiding.  
- Basic knowledge of classes, derived classes, methods.  
- Object-oriented methodology for designing data structures and applicable programs.  
- Problems that are naturally solved using object-oriented design and programming methodology.

**learning outcomes**

With acquired knowledge student can:  
- to recognize the conditions for using object-oriented design and programming methodology,  
- to design simple user class and link them with the system classes,  
- user to design simple methods and their use in system design methods,  
- to use the programming languages C++ and Java.

**theoretical teaching**

Compilers, interpreters and machines. Weak and strong typed programming languages.  
Object and class, relationship and real-life examples and techniques.  
The natural definition of class, subclass, supclass. The term instance - the object.  
Fundamentals of programming language C++. The differences between the programming languages C and C++.  
Defining classes in C++. Application of operations and creating objects.  
Object-oriented design data, operations, and problems in the programming and implementation.  
The life span of the object.  
The basics of Java programming. The differences between the programming languages C++ and Java.  
Defining the class and subclass supclass in programming languages C++ and Java.  
Inheritance in C++ and Java, the advantages and disadvantages.  
Overloading of operators and create threads and streamline, as well as specific structures in Java.  
Problem encapsulate objects and classes. The advantages and disadvantages.

**practical teaching**

It consists of auditory, laboratory exercises that accompany the course.  
The commemoration of the programming language PHP programming.  
Basic examples of the programming language C++ and Java.
prerequisite

With the knowledge C language. Basic knowledge of design methodology. Fundamentals of software engineering.

learning resources

The necessary software for this case under the GNU license - free of charge. If necessary use a Linux C++ and JAVA will immediately available. If you use another operating system C++ can be downloaded from the appropriate Web site (see URL) or the URL. To run the software necessary to possess enough simplest PC.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 11
laboratory exercises: 19
calculation tasks: 0
seminar works: 5
project design: 2
consultations: 0
discussion and workshop: 3
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 7
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 3
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 35
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Power steam boiler 1

ID: MSc-1116  
responsible/holder professor: Stupar M. Goran  
teaching professor/s: Stupar M. Goran  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written  
parent department: thermal science engineering  
semester.position: 1.2

goals

Reaching the competence and academic skills and methods for it's acquiring. Developing creative capabilities and mastering the specific practical skills. Goals determine the specific results which should be achieved within the subject. Goals also represent basis for control of the achieved results. Activities in this subject are in accordance with basic tasks and goals of the study program.

learning outcomes

After successfully completing the course, the students will be able to:  
• Calculate the material balance of the combustion process and the enthalpies of combustion products for solid fuels.  
• Choose the excess air and apply flue gases recirculation.  
• Get to know more about the structure of the irradiated and convective evaporator.  
• Acquainted with the main superheater types and temperature control systems of a superheated vapor.  
• Acquainted with the basic types of water heaters and air heaters.  
• Calculate the heat balance of the steam boiler and its heat surfaces.

theoretical teaching

Working principle of a steam boiler and definitions of basic concepts; Fuels for steam boilers; Combustion material balance; Excess air; Flue gases enthalpy; Steam boiler heat balance, losses and efficiency; Steam boiler furnace; Steam boiler evaporators with natural and forced circulation loop; Half-radiation and convection evaporators; Radiation, half-radiation and convection superheaters; Reheaters; Different types of water heaters; Recuperative air heaters and regenerative air heaters.

practical teaching

Auditory exercises consist from demonstration exercises(classification of boilers; steam boiler construction; main and auxiliary devices and equipment); Working project - coal combustion material balance (coal calorific value, theoretical air volume for combustion , theoretical flue gas volume, flue gases enthalpy diagram as a function of temperature and excess air); working principle of a industrial steam boiler; weternizing the losses, efficiency and fuel consumption of the given steam boiler; furnace dimensioning; heat and material balance of steam boiler heating surfaces.

prerequisite
Necessary condition: Bachelor's degree.

**learning resources**

Books: Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers, Faculty of Mechanical Engineering, Belgrade, 2010, (In Serbian); Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers Thermal Calculation, Faculty of Mechanical Engineering, Belgrade, 2010, (In Serbian); handouts which will be at student's disposal a week in advance.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 0
discussion and workshop: 10
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 4
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 40
requirements to take the exam (number of points): 30

**references**
Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers, Faculty of Mechanical Engineering, Belgrade, 2010, (In Serbian)
Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers Thermal Calculation, Faculty of Mechanical Engineering, Belgrade, 2010, (In Serbian)
Pumps

**ID:** MSc-0443  
**responsible/holder professor:** Nedeljković S. Miloš  
**teaching professor/s:** Nedeljković S. Miloš, Čantrak S. Đorđe  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** hydropower engineering  
**semester.position:** 1.2

**goals**

Mastering knowledge of engineering applications of pumps as machines for raising of fluid energy. Capacity to work in practice on energy installations, as well as design of installations that include a pump as a built-in element with its function.

**learning outcomes**

After finishing this course, the students should be able to:  
1. Know and recognize the types and designs of pumps,  
2. Calculate the pump/system energy parameters and energy balancing,  
3. Calculate and apply the dimensionless parameters - characteristic performance factors,  
4. Determine the pump/system working point,  
5. Apply the energy characteristics of pumps for establishment of operating regimes, as well as in their regulation.  
6. Calculate the pump and the system cavitation characteristics,

**theoretical teaching**


**practical teaching**

Demonstrative laboratory exercises: Institute (laboratory) for hydraulic machinery - showing PF constructions and description of the role of individual parts. Pump installations and
description of their work.

prerequisite

The Fluid Mechanics B exam obligatory passed. Desirable that the student has passed the examination of the subject Introduction to Energy Engineering.

learning resources

Handouts for the exercises.
Laboratory for hydraulic machines - equipment, installations, measuring equipment.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 26
laboratory exercises: 2
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 10
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 70
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 21
references
Refrigeration Equipment

ID: MSc-1114  
responsible/holder professor: Milovančević M. Uroš  
teaching professor/s: Milovančević M. Uroš  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written  
parent department: thermal science engineering  
semester.position: 1.2

goals

Achieving of competence and academic skills as well as methods for their acquisition. The development of creative abilities and practical skills which are essential to the profession. Objectives are concrete and achievable and in full accordance with the defined basic tasks and objectives of the study program.

learning outcomes

Student acquires subject-specific abilities that are essential for the quality of professional activities: analysis, synthesis and prediction of solutions and consequences; application of knowledge in practice; linking the basic knowledge in various fields with their application to solve specific problems.

theoretical teaching

Refrigeration compressors (systematization, application); Reciprocating refrigeration compressors: basic elements, basic parameters of operation, operating characteristics (performance) of reciprocating refrigeration compressors, processes in an Ideal and actual compressor, volumetric efficiency, Actual compression process, Capacity control of reciprocating compressors); Rotary refrigeration compressors, twin screw compressors; Auxiliary equipment and refrigeration pipelines, Condensers: classification of condensers, analysis of condensers; Evaporators: classification, direct expansion fin-and-tube type evaporators, flooded evaporators, evaporator defrosting; Expansion devices: thermostatic expansion valve.

practical teaching

Auditory training: A survey of the application area of certain types of compressors; Volumetric efficiency calculation; The compressor displacement calculation; Capacity control of reciprocating compressors; Design of rotary screw compressors; Compressor performance curves; Calculation of refrigeration load of condensers, Calculation of piping, insulation, safety valves and elements of automation.  
Laboratory exercise: demonstration of cooling installation in an industrial plant; Design project of refrigeration system: work in groups of 5 students (for a particular object and refrigerant), calculation and selection of elements refrigeration plants.
prerequisite

Required exams passed: thermodynamics, the basics of refrigeration

learning resources

1. Textbook: M. Markoski: Refrigeration, Mechanical Engineering, 2006,

2. Handouts which are available in advance for each week of classes

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 15
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 50
requirements to take the exam (number of points): 0

references


Refrigeration in Food Technologies

ID: MSc-1115
responsible/holder professor: Milovančević M. Uroš

level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written

parent department: thermal science engineering

goals

Achieving of competence and academic skills as well as methods for their acquisition. The development of creative abilities and practical skills which are essential to the profession. Objectives are concrete and achievable and in full accordance with the defined basic tasks and objectives of the study program.

learning outcomes

Student acquires subject-specific abilities that are essential for the quality of professional activities: analysis, synthesis and prediction of solutions and consequences; application of knowledge in practice; linking the basic knowledge in various fields with their application to solve specific problems.

theoretical teaching

Natural and artificial refrigeration, Application of refrigeration, Vapour compression refrigeration systems, The Carnot vapour compression refrigeration cycle, Improvement of vapour compression cycle, (subcooling, multistage throttling, multistage compression with intercooling), Standard vapour compression refrigeration plants, Refrigerant, refrigerant selection criteria; Designation of refrigerants; Reciprocating refrigeration compressors: Basic elements, basic parameters of operation, operating characteristics (performance) of reciprocating refrigeration compressors; Condensers: classification of condensers; Evaporators: classification, evaporator defrosting; Cooling and quick freezing of food products

practical teaching

Auditory training: Moist air, thermodynamic properties of moist air, Mollier's "h-x" diagram, Important psychrometric processes, thermal insulation, selection of insulation materials, the diffusion of water vapor through thermal insulation layer, vapour barrier, calculation of refrigeration load, thermodynamic analyses of refrigeration cycle, Basic calculation for sizing of compressors, condensers and evaporators, process systems for quick freezing and storage of food products;
Laboratory Exercise: Demonstration of refrigeration devices in industrial plants; Design project of refrigeration system: work in groups of 5 students (for a particular object and refrigerant), calculation of a refrigeration plant.
prerequisite

Required exams passed: Thermodynamics B; Desirable passed exam: Fluid Mechanics B

learning resources

1. Textbook: M. Markoski: Refrigeration, Mechanical Engineering, 2006,
2. Handouts which are available in advance for each week of classes

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 15
laboratory exercises: 3
calculation tasks: 0
seminar works: 0
project design: 12
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 45
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 15
final exam: 30
requirements to take the exam (number of points): 21

references
Ship strength 1

ID: MSc-1015

responsible/holder professor: Momčilović V. Nikola

teaching professor/s: Momčilović V. Nikola

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: written

parent department: naval systems

semester.position: 1.2

goals

The aims are to explain: basic modes of ship structure failure and limit state assessment of ship structure, general simplification of the hull mathematical model and the concept of strength calculations by using analytical and numerical methods.

learning outcomes

1. A thorough knowledge about the concept of ship strength calculations in contemporary shipbuilding practice. 2. Qualification for practical application of analytical methods of theory of elasticity in direct calculations of ship structures and analysis and development of classification societies’ rules.

theoretical teaching

The student is familiarized with various types of ship structure failure and limit states. Basic hull loadings are considered and their classification into static, quasi-static and dynamic ones is explained. Basic concept of the analysis of primary, secondary and tertiary structure response is explained as well as conditional division of those calculations into longitudinal, transverse and local strength. Studies comprise, first of all, analytical and some numerical methods for calculations of beams, grids, unstiffened and stiffened plates of ship structure. Explanations are given of a general concept of the corresponding hull mathematical model, simplifications to be applied for the sake of analytical methods use, limitations of such approach to analysis, and alternative numerical methods that help to overcome those limitations.

practical teaching

Calculation tasks are used to develop student ability to independently do strength calculations of beams and plane grids of ship structure, and analysis of bending and stability of unstiffened plates and stiffened panels of ship structure. In modern engineering practice those skills are needed in both direct calculations of the hull strength and for understanding and development prescriptive formulas in classification societies’ rules.

prerequisite

Defined by the Study Program Curriculum.

learning resources

1. Examples of solved calculation tasks /In Serbian/. 2. Shipbuilding rules by various classification societies /In Serbian and English/.
number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 17
laboratory exercises: 0
calculation tasks: 10
seminar works: 0
project design: 0
consultations: 3
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 5
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 50
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 10

references

Structural Analysis

ID: MSc-0947
responsible/holder professor: Petrašinović M. Danilo
teaching professor/s: Grbović M. Aleksandar, Dinulović R. Mirko, Petrašinović M. Danilo
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: aerospace engineering
semester.position: 1.2

goals

1. Introduction to problems and modern calculation methods in stress analysis of aircraft structures, as well as their application to solving real problems.
2. Introduction to experimental stress analysis of aircraft structures.
3. Introduction to thin walled structures and composite materials.
4. Introduction to modern computational methods for stress analysis related to airframe structures.

learning outcomes

1. Mastering basic structural analysis theories.
2. Application of theoretical knowledge to solve practical problems.
3. Understanding the basis of aircraft design process.

theoretical teaching


practical teaching


In practical part of the course, previous theories are demonstrated in real applications. Numerous problems are analyzed. Practical student work is carried out through mandatory exercises using computers for modeling and analysis. Practical part of the course also includes the visit to the laboratories for static and dynamic experimentation of the VTI institute.
prerequisite

Recommended: Theory of elasticity, Structural analysis of aircraft structures

learning resources

Handouts in e-format, demonstration films and computer simulation, Internet resources.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 5
seminar works: 0
project design: 10
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 5
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 10
seminar works: 0
project design: 20
final exam: 40
requirements to take the exam (number of points): 40

references
Introduction to Aircraft structural Analysis, T. Megson
Structural Analysis with Finite Elements, Hartmann
System Effectiveness

ID: MSc-0711
responsible/holder professor: Vasić M. Branko
teaching professor/s: Blagojević A. Ivan, Vasić M. Branko
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: motor vehicles
semester.position: 1.2

goals

The objectives of the course are to provide a comprehensive insight into the issues (analysis and design) of system effectiveness, primarily in the areas of reliability and availability of technical systems (vehicles).

learning outcomes

Upon successful completion of this course, students should be able to:
- Explain the concepts of system effectiveness, reliability and failure;
- Analyze the obtained failure time data;
- Apply of the basic laws of probability and statistics to calculate the reliability;
- Obtain theoretical probability density and reliability function based on empirical data on failures of the elements;
- Determine the reliability of a complex system based on the reliability of the elements that form a complex system;
- To form fault tree of technical system and analyze it;
- To design machine elements on the basis of reliability.

theoretical teaching

Defining the requirements for effectiveness and reliability and availability of system elements and system. The system. The basis of probability theory and statistics and its application in analysis and design of reliability. Definition of failure of the elements and system. Determination of empirical and theoretical characteristics of reliability of the elements of a system and of the systems (histogram, polygon, intensity of failure, the function of frequency, mean value, distribution laws (Weibull, normal, exponential, binomial, Poisson), tests of trust, confidence interval). Determination of reliability block diagrams of simple and complex systems (vehicles) with the application of probability theory of complex events. Fault tree analysis, the analysis of mode, effect and criticality of faults, integrated system approach. Design of vehicle elements for a given level of reliability, relations of workload and critical load, the selection of intensity of failures for specific working conditions and environment.

practical teaching

tree analysis, analysis methods, effects and criticality of failures.

1. Examples.
2. Examples - Independent work.

prerequisite

No previous preconditions.

learning resources


number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 15
laboratory exercises: 0
calculation tasks: 15
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 8
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 4
test, with assessment: 0
final exam: 3

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 30
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 40

references

**Theory of Traction**

**ID:** MSc-1187  
**responsible/holder professor:** Tanasković D. Jovan  
**teaching professor/s:** Lučanin J. Vojkan, Tanasković D. Jovan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** railway mechanical engineering  
**semester.position:** 1.2

**goals**

Knowledge acquiring in designing, production and exploitation of railway vehicle, in designing of rail tracks as well as the organization of railway traffic. Introducing students with:
- The Forces acting on railway vehicle,
- Calculation methods for traction, resistance and braking force and the velocity, using modern computer tools,
- The methods for determination of optimal movement conditions of railway vehicles,
- Ways of solving practical problems related to the movement of railway vehicles and rail tracks configuration.

**learning outcomes**

After successfully finishing of course students would be able to:
- define tasks and way of functioning elements, subassemblies and assemblies of tractive vehicles;
- calculate tractive effort, train resistance, braking force and velocity of railway vehicle using special software package;
- discuss about advantages and disadvantages of the different types of power transmissions and their characteristics;
- assessment of advantages and disadvantages of different types of coupling which can be used in tractive railway vehicles;
- implementation of regulations and standards in the field of railway vehicle traction.

**theoretical teaching**

Characteristics of the railway transport, Analysis of the influencing factors on the traction forces, Transmission of traction forces – adhesion as requirement for traction forces, Traction features of high-speed railway vehicles, Traction features of the diesel traction railway vehicles, Basic characteristics of running gear and drive of traction vehicle, Traction features of the electric traction railway vehicles, Train resistance – main and additional resistance, High speeds train resistance, Railway vehicles braking force – characteristics of the braking process, Equations of the train.

**practical teaching**

Practical learning, Auditory exercises (Introduction to the examples in modern railway transport, Recapitulation of learned material necessary for passing this subject (mechanics, machine elements and electrical engineering), Using of computer tools to solve problems in train traction, Guidance of wheel set in track, The relative velocity of wheel set in relation to...
the rail, Forces at the wheel set edge point and the contact point of the wheel-rail , Basic characteristics of traction features, adhesion as requirements for traction forces , Basic characteristics of diesel and electric traction railway vehicles, The resistance forces in motion the train, Task (Determination of traction characteristics of the diesel traction vehicles with mechanical and hydraulic power transmission, Determination of traction characteristics of the diesel traction vehicles with electric power transmission, Determination of traction characteristics of the electric traction vehicle, Analytical determination of the resistance force when moving train, Solving differential equations of train ), Discussions and workshops.

**prerequisite**

Nothing

**learning resources**

Literature that is available in the Faculty Bookstore and Library; Handouts available on lectures; Internet resources (KOBSON).

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 9
laboratory exercises: 0
calculation tasks: 11
seminar works: 0
project design: 0
consultations: 5
discussion and workshop: 5
research: 0

**knowledge checks**

check and assessment of calculation tasks: 5
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 5
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 30
seminar works: 5
project design: 0
final exam: 35
requirements to take the exam (number of points): 35

references

Lucanin, V., Theory of Traction, Faculty of Mechanical Engineering, Belgrade, 1996.
Tractors and self-propelled agricultural machines

ID: MSc-0298
responsible/holder professor: Marković D. Dragan
teaching professor/s: Marković D. Dragan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: agricultural engineering
semester.position: 1.2

goals

1. Master the theoretical foundations of power machines-tractors and self-propelled agricultural machine-harvesters; 2. Conception and construction of farm tractors, small tractors and self-propelled chassis; 3. Transmission systems and for connecting the working machinery and mechanisms; 4. Concept of simultaneous transmission of power through the drive wheels and auxiliary shafts, energy balance, 5. The theory of operation, concept and design combines, budgets drive the moving parts and technological devices combine.

learning outcomes

After successful completion of the new course, studenty should be able to:
- Manage the procurement of tractors of appropriate to the characteristics of the available agricultural mechanization tractor by aggregating,
- Organize and water exploitation and maintenance of tractors and self-propelled agricultural machines,
- Perform and implement solutions different conceptions of tractors and self-propelled chassis,
- Make a plan of testing of tractors,
- Identify, formulate and control the ergonomic requirements of the operator.

theoretical teaching


practical teaching

Laboratory exercises:
1. Practical introduction to technical solutions assemblies tractors, small tractors and self-propelled chassis;
2. Practical introduction to technical solutions and components and technological devices combine.
Computational tasks:
1. Development of arithmetic problems using computers and modern software packages in the field of tractors;
2. Development of arithmetic problems using computers and modern software packages in the field of universal self-propelled combine.
Development of the project:
1. Conceptual design of the tractor and operating self-propelled chassis;
2. Preliminary design in the field of universal self-propelled combine.

**prerequisite**

Attended courses of previous years of study and all the conditions defined curriculum of study program / module

**learning resources**

1. Novaković Vl.: Agricultural machinery 1, Belgrade;
2. Marković D.: Agricultural tractors, written lectures, Belgrade, 2006.;

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 5
calculation tasks: 5
seminar works: 0
project design: 20
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 2
check and assessment of lab reports: 1
check and assessment of seminar works: 0
check and assessment of projects: 7
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 10
calculation tasks: 10
seminar works: 0
project design: 40
final exam: 30
requirements to take the exam (number of points): 50

references

Martinov M., Markovic D.: Machinery and tools for soil cultivation, the first part, FTN, 2002.;
Gligoric R., Mechanisms of agricultural machinery-with the settlement tasks, PF, Novi Sad, 2005.
Fluid mechanics M

ID: MSc-0685

**responsible/holder professor:** Crnojević Đ. Cvetko

**teaching professor/s:** Lečić R. Milan, Ćoćić S. Aleksandar, Crnojević Đ. Cvetko

**level of studies:** M.Sc. (graduate) academic studies

**ECTS credits:** 6

**final exam:** written+oral

**parent department:** fluid mechanics

**semester.position:** 1.3

**goals**

The goal of the course is to teach the student the basics and applications in science of fluid flow. The essence in that sense is good understanding of fundamental equations of fluid mechanics. That good understanding of the equations makes the process of finding the solution in particular engineering problems which are dealing with fluid flow much easier.

**learning outcomes**

Learning the topics from the course student will get the knowledge about basic principles in fluid mechanics and capabilities of analytical thinking, then how to apply the knowledge in practical work, and also to make the connection between various subjects from mechanical engineering.

**theoretical teaching**


**practical teaching**


**prerequisite**

That the student passed the previous level object that contains the basics of fluid mechanics.

**learning resources**

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 26
laboratory exercises: 4
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 3
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 45
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 20

**references**
Mechanics M

ID: MSc-0004

responsible/holder professor: Mitrović S. Zoran


level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: oral

parent department: mechanics

semester.position: 1.3

goals

The aim of this course is that students learn the elements of the dynamics of the oscillatory motion of a particle, the dynamics of variable mass particle, advanced problems in kinematics of a particle, kinematics of a complex motion of a rigid body and mechanical system of rigid bodies as well as the dynamics of spherical and general rigid body motion, the approximate theory of gyroscope and the impact theory.

learning outcomes

Upon successful completion of this course, students should be able to:

• Solve problems related to all kinds of rectilinear oscillations of a particle and material systems with one degree of freedom.
• Analyze the motion of variable mass particle.
• Create expressions for velocity and acceleration of a particle in curvilinear coordinates.
• Describe the general motion of a rigid body and carry out the synthesis of translational and rotational motion.
• Distinguish analytical cases of spherical rigid body motion described by Euler dynamic equations and cases of approximate theory of gyroscopic phenomena using Rezal theorem.
• Solve problems related to the impact (collision) of a particle and rigid body.

theoretical teaching


practical teaching

Introduction to the kinematics of rigid body systems. Dynamics of spherical and general body motion. Approximate theory of gyroscope. Gyroscopic torque. The basic impact theory. The impact coefficient. Theorems about the changes of linear and angular momentum during the impact.

prerequisite

Defined by the curriculum study of graduate studies program.

learning resources

[4] Handouts

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 10
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 60
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

references

Mechatronics

**ID:** MSc-1150  
**responsible/holder professor:** Veg A. Emil  
**teaching professor/s:** Veg A. Emil, Miladinović D. Ljubomir, Šiniković B. Goran  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** theory of mechanisms and machines  
**semester.position:** 1.4

**goals**

Mastering the knowledge fund required for competent analysis of the structure of the mechatronic solution, defining the executive mechanism, the control module and the work algorithm. Developing the creative ability to set up a conceptual mechatronic solution for the problem, which will optimally meet the defined technical requirements.

**learning outcomes**

Possessing the engineering capabilities to perform a qualitative analysis of the mechanisms of the electronic and processor modules as key sub-blocks of a mechatronic solution. Based on complete mastering of an inverse engineering task (analysis), active solving of a direct engineering task, synthesis of the original mechatronic solution.

**theoretical teaching**

Theory teaching; Introduction to mechatronics; Intelligent machine circuits, systems and their application., Design in mechatronics; Initial vision of the concept of mechatronic solution, Mechanisms in mechatronics; Science on the theory of machines and mechanisms. Classification of mechanisms, Measurements in mechatronics 1; Analog and digital sensors, Measurements in mechatronics 2; Definition of photodiode light and phototransistors, Actuators in mechatronics; Linear and rotary actuators, Actuators with motion transformation, Digital and analogue electronic modules; Logic circuits and applications, Detection of state (0,1), Management concepts in mechatronics; Structure of the processor system, Programming the system; Programming tools available, Programming input ports, Programming output ports

**practical teaching**

Practical teaching; laboratory exercises; Display of typical mechatronic solutions; Turbocharger with variable geometry, Decomposition of mechatronic solution; Analysis of elements, functions and signals of the sensor block, Elemental mechanisms; Examples of different configuration mechanisms for performing certain motion profiles, Sensors 1; Measurement of analogue sizes using PC-platform and Lab View software package, Sensors 2; Developing the idea for solving the user numerical-graphic display of results, Actuators; Motorized frequency drive control; Operational amplifier, Working with PC-platform, Working with PIC-platform;

**prerequisite**

Presence on the lectures is mandatory (at least 80% of lectures).
learning resources

Models of mechanisms (articulated four-wire, piston mechanism) Set of sensors (thermocouples, inductive accelerometers, opto sensors). DC PIC development system Pneumatic components (cylinders, valves, PLCs)

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 45

active teaching (practical)

auditory exercises: 0
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 0
discussion and workshop: 5
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 0

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 50
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 30
requirements to take the exam (number of points): 35

references

Mali rečnik mehatronike, A. Veg, G. Šiniković, E. Veg, M. Regodić
Thermodynamics M

ID: MSc-0202

responsible/holder professor: Komatina S. Mirko

teaching professor/s: Banjac J. Miloš, Gojak D. Milan, Komatina S. Mirko

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: written+oral

parent department: thermomechanics

semester.position: 1.4

goals

Student should gain knowledge in thermodynamics and thermal devices and plants that are present in process engineering, thermal engineering and power engineering. Through practical and theoretical education should understand from thermodynamic aspect the transformation of thermal energy into mechanical work and gain physical fundamentals on phenomena that go on in steam turbine, gas turbine and refrigeration devices as well as in plants for drying various materials and air conditioning of corresponding spaces.

learning outcomes

Upon successful completion of this course, students should be able to:

• Interpret, explain and implement the First and Second principle of thermodynamics to the closed and open thermodynamic systems.
• Interpret and apply the equations of state of real gases and explain their deviations from the ideal gas model.
• Recognize the devices in which real thermomechanical processes are evolved and perform their thermodynamic analysis.
• Determine the energy indicators of the ideal gas and real right-handed and left-handed cyclic processes with and perform their thermodynamic analysis.
• Recognize and describe the exergy of the open and closed thermodynamic system.
• Apply the energy and exergy analysis of thermomechanical processes on devices and facilities.
• Recognize and determine the thermodynamic properties of wet gases and implement them in the analysis of thermomechanical processes in devices and facilities with moist air.

theoretical teaching

2. Second law of thermodynamics for open thermomechanic systems.
3. Exergy of closed and open thermomechanic systems.
4. Thermodynamic analysis of operation of basic thermomechanic devices and plants.
5. Thermodynamics of complex systems, outflow.
6. Humid air - devices and plants that operate with humid air.

practical teaching

1. Numerical exercises on First law of thermodynamics for open thermomechanic system.
2. Numerical exercises on Second law of thermodynamics for open thermomechanic systems.
3. Numerical exercises on exergy of closed and open thermomechanic systems.
4. Numerical exercises on thermodynamic analysis of operation of thermomechanic devices
5. Numerical exercises on thermodynamics of complex systems.
6. Numerical exercises on processes, devices and plants that operate with humid air.

**prerequisite**

Necessary: Physics, Thermodynamics B

**learning resources**

5. Handouts for Thermodynamics M, site of Mašinski fakultet, Beograd.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 25
laboratory exercises: 0
calculation tasks: 5
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 4
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 3
test, with assessment: 3
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 60
laboratory exercises: 0
calculation tasks: 0
seminar works: 5
project design: 0
final exam: 35
requirements to take the exam (number of points): 20

references

A. Bejan: Advanced Engineering Thermodynamics, John Wiley & Sons, 1988
Aircraft Performance

ID: MSc-0948  
responsible/holder professor: Bengin Č. Aleksandar

**teaching professor/s:** Kostić A. Ivan, Mitrović B. Ćaslav, Peković M. Ognjen

**level of studies:** M.Sc. (graduate) academic studies

**ECTS credits:** 6

**final exam:** written

**parent department:** aerospace engineering

**semester.position:** 1.5

**goals**

Introducing students to the complex movement of aircraft in atmospheric flight. During the course will be studied the performance of the aircraft, i.e. will be studying the movement of the aircraft’s center of gravity under the action of forces. Within the Course Term Project Assignment, that covers and integrates the entire course material, students will be able to obtain performance of the aircraft, individually with the use of modern software packages, such as Matlab, Mathcad, Excel, etc.

**learning outcomes**

Mastering the course, the student acquires enough theoretical knowledge to be able individually and creatively to define performance capabilities of modern aircraft and all restrictions that result from them. In this course, students will gain full sublimation and verification of previously acquired knowledge and skills they have acquired within the Aeronautical module from the group of aerodynamic courses.

**theoretical teaching**


**practical teaching**


**prerequisite**

Required: Aerodynamic design

**learning resources**

Books, Maido Saarlas, Aircraft Performance, John Wiley & Sons, Inc, Hoboken, New Jersey, 2007, include necessary material for lectures, exercises, assignments, projects and term papers. Require additional materials (handouts, setting assignments, term papers, etc..) Are given at the web site or reproduced on paper. Large-scale electronic materials can be made available to students in direct contact.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 0
calculation tasks: 5
seminar works: 0
project design: 0
consultations: 10
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 10
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 15
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 10
seminar works: 0
project design: 45
final exam: 30
requirements to take the exam (number of points): 35
references
Avionics

ID: MSc-0311
responsible/holder professor: Petrović B. Nebojša
teaching professor/s: Peković M. Ognjen, Petrović B. Nebojša
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: aerospace engineering
semester.position: 1.5

goals

Objectives of the course are to introduce students to aviation electronic equipment and systems, their functions, structures and basic principles. The subject should provide students a detailed view of the latest trends in avionics technology and development.

learning outcomes

Successful completion of course students acquire the ability to understand the existing solutions aviation electronic equipment and systems. The student acquires knowledge about the structures of various types of avionics equipment and systems. The knowledge that allow students to opt for other aviation issues to understand the electronic aviation equipment and systems, and for those who want to specialize in these issues are fundamental to the acquired knowledge for further work.

theoretical teaching


practical teaching


prerequisite

Faculty of Mechanical engineering — course catalog — M.Sc. (graduate) academic studies

148
The condition of attending the course is student enrollment in the semester in which this subject is taught.

**learning resources**

Written sources from the lecture.
Written sources from the auditory exercises.
Civil Avionics Systems, I. Moir and A. Seabridge
Intelligent piezo actuators, N. Petrovic

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**
The Avionics Handbook, Cary R. Spitzer
Buoyancy and Stability of Ship 1M

**ID:** MSc-0973  
**responsible/holder professor:** Bačkalov A. Igor  
**teaching professor/s:** Bačkalov A. Igor  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** naval systems  
**semester.position:** 1.5

**goals**

To cover the basic knowledge of Naval Architecture connected to ship form, ship buoyancy, stability, and ship hydrostatic calculations (hydrostatic curves and stability). Buoyancy and stability is one of the basic professional courses hence taught in all the departments (faculties) with courses in naval architecture.

**learning outcomes**

Practical knowledge in ship line plan drawing, and in the basic hydrostatic calculations (hydrostatic curves, stability cross curves, righting arm). Ability in solving and analysis of practical engineering tasks connected to ship buoyancy and stability.

**theoretical teaching**


**practical teaching**

Practical problems of ship buoyancy and stability, illustrating the subjects lectured in theoretical syllabus. In addition, students work individually on three classical hydrostatic projects: ship lines drawing, ship hydrostatic curves and ship stability. The projects are completed in the Final Course Report (B.Sc. work), and defended after the sixth semester.

**prerequisite**

The previous study year completed. Semester 5 enrolled.

**learning resources**

[1] Milan Hofman: Extracts from lectures (handouts)  
[3] Igor Bakalov: Instructions for projects in buoyancy and stability of ship
number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 15
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 15
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 10
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 40
final exam: 50
requirements to take the exam (number of points): 34

references

Biran, A., Ship Hydrostatics and Stability, Butterworth Heinemann 2003
Central Heating Systems

ID: MSc-0661
responsible/holder professor: Todorović N. Maja
Teaching professor/s: Bajc S. Tamara, Todorović N. Maja
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: thermal science engineering
semester.position: 1.5

goals

Acquiring knowledge and skills in the field of central heating - hot water two-pipe systems with natural and forced circulation of hot water, hot water one-pipe systems, steam heating system of low pressure, air heating, panel heating, district heating, solar systems, mastering the methods for calculation of pipe network.

learning outcomes

Students acquire specific skills and knowledge of central heating systems: knowledge of different heating systems, known methods of calculation of central heating systems and can apply them in practice. Connects basic knowledge and apply it to solve concrete problems in the technique of heating.

theoretical teaching

Two-pipe hot water central heating pump systems, pipe heating system; correction of surface heaters, heating steam low pressure, upper and lower divorce; Steam traps, condensate return to boiler; calculation of pipe networks, heat transfer by radiation; panel heating systems, heat transfer from the budget tube, through multi-layered plate, the surrounding air, underfloor heating, air heating, ventilation chamber and its components, industrial ventilation, remote distribution of heat; characteristics of district heating, heat transport distance; substation for direct and indirect connection; heating sliding diagrams, renewable energy sources, active and passive use of solar energy and geothermal energy.

practical teaching

Auditory exercises consist of parts: pipe sizing for two-pipe hot-water network system with natural and forced circulation of water in the system and facilities 90/70oC to prepare and distribute hot water, and to individual work of reference. Lab exercise - testing thermal properties of heaters; temperature impact on the heat output of radiators; influence of the flow rate to heat output of radiators; behavior of heaters in non-stationary conditions (visit the exhibition of thermal engineering in the Congress of HVAC or visit the factory).

prerequisite

In order for a student attending the subject must have passed the exams in the subject: Thermodynamics B and Heating technique Fundamentals

learning resources

Handouts - M. Todorović
B. Todorović - Central Heating Systems Design - Faculty of Mechanical engineering, Belgrade, 2009.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 15
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 50
requirements to take the exam (number of points): 21

**references**

B. Todorović - Central Heating Systems Design - Faculty of Mechanical engineering, Belgrade, 2009.
Combustion for propulsion systems

**ID:** MSc-1144  
**responsible/holder professor:** Milivojević M. Aleksandar  
**teaching professor/s:** Milivojević M. Aleksandar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** engineering materials and welding, tribology, fuels and combustion  
**semester.position:** 1.5

**goals**

Propulsion systems are mostly based, except a few exceptions, on liberated energy in combustion processes. The goal of the “Combustion for Propulsion Systems” is to enable a student deeper understanding of combustion processes and to qualify them to take part in analyses, development and application of propulsion systems.

**learning outcomes**

After successful completion of this course, students should be able to:  
- analyze existing and future propulsion systems regarding combustion,  
- apply the acquired knowledge in the design and development of propulsion systems,  
- work in scientific and research organizations in areas of propulsion and combustion.

**theoretical teaching**


**practical teaching**

Practical tuition includes numerical analysis of examples of conservation laws, stoichiometry, thermochemistry and chemical kinetics. Experimental research includes diffusion and premixed flame and burner characterization. A student will numerically solve a problem in propulsion combustion.

**prerequisite**

None

**learning resources**

The subject Handouts.

**number of hours**

**total number of hours:** 75

**active teaching (theoretical)**
lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 5
calculation tasks: 5
seminar works: 5
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 3
check and assessment of lab reports: 2
check and assessment of seminar works: 3
check and assessment of projects: 0
colloquium, with assessment: 2
test, with assessment: 3
final exam: 2

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 10
calculation tasks: 15
seminar works: 5
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**

A. Milivojevic, Subject handouts
Principles of Combustion (Принципи сагоревања), Kenneth K. Kuo, BARNES & NOBLE
Computer Networks

ID: MSc-0528
responsible/holder professor: Mitrović B. Časlav
teaching professor/s: Bengin Č. Aleksandar, Vorotović S. Goran, Mitrović B. Časlav
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: project design
parent department: information technologies
semester.position: 1.5

goals

Course objective:
• Introduction to the concept, standard tasks and operation of computer networks.
• Introduction to the protocol and other factors that control, manage and participate in creating a variety of processes and resources of computer networks and computers.

learning outcomes

The acquired knowledge allows students:
• to identify and suggest the type of computer network,
• to understand the problems that arise when designing computer networks,
• to create a project of computer network that includes a suggestion purchase of necessary equipment.

theoretical teaching

The basics of networking. The basic components of computer networks. Hardware. Software. The reasons for networking. The network environment. Use of Information. Passive network equipment. The active network equipment. Protocols. Computer interfaces. Standard computer networks. The division of computer networks. Grouping according to the capacity of computer networks for the transmission of data, the speed of transmission, according to a hierarchical or geographic area, according to the topology or logical and physical layout of nodes, as compared to nodes in a network, the architecture of computer networks and the access to computer networks.
Transport layer. TCP, UDP, SCTP, SPX, iSCSI.

practical teaching

It consists of auditory, laboratory exercises that follow the content of course
prerequisite

Required: Basic computer culture based on the use of a PC, regardless of operating systems. WEB design in mechanical engineering, Software Engineering.

learning resources

The necessary software for this case under the GNU license - free of charge.

• To run the necessary software is enough to have the simplest PC.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 6
laboratory exercises: 21
calculation tasks: 0
seminar works: 7
project design: 3
consultations: 0
discussion and workshop: 3
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 7
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 3
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 15
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 20
final exam: 30
requirements to take the exam (number of points): 35

references
Construction, mining and conveying machinery elements

ID: MSc-0790
responsible/holder professor: Bošnjak M. Srđan
teaching professor/s: Bošnjak M. Srđan, Gnjatović B. Nebojša
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: material handling, constructions and logistics
semester.position: 1.5

goals

Basic course goals are: 1) introducing students to construction, design and calculations of basic construction, mining and conveying machinery elements; 2) mastering of practical skills required for design and calculation of construction, mining and conveying machinery.

learning outcomes

Goal of this course is to introduce the students to the following skills:
- Modeling and calculation of unique below-the-hook lifting devices;
- Design, modeling and calculations related to fundamental substructures of crawler systems;
- Modeling and calculation of bearing structures of mobile construction, transport and mining machines;
- Design and calculation of stabilizers;
- Computer-aided modeling and creating technical documentation of elements and assemblies of machines used in construction, mining and material handling processes.

theoretical teaching


practical teaching


prerequisite

Elements 2, Fundamentals of steel structures

**learning resources**

Srđan Bošnjak, Bucket Wheel Trenchers, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, 2001., Srđan Bošnjak, Handouts, University of Belgrade, Faculty of Mechanical Engineering, Belgrade.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 20

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 30
requirements to take the exam (number of points): 35

**references**
Vinko Jevtić - Construction and Mining Machines, Faculty of Mechanical Engineering Nis, 1993.
Coordinate Measuring Machines

ID: MSc-1166
**responsible/holder professor:** Stojadinović M. Slavenko
**teaching professor/s:** Stojadinović M. Slavenko
**level of studies:** M.Sc. (graduate) academic studies
**ECTS credits:** 6
**final exam:** oral
**parent department:** production engineering
**semester.position:** 1.5

goals

The objective of the course is acquire of knowledge and skills in the field of coordinate metrology and flexible metrological automation for solving metrological problems primarily in production engineering, and then in other engineering disciplines. Students should acquire and to master new knowledge and skills abouth: basic terms, development and application of coordinate measuring machine (CMM) in engineering practice; subsystems of CMM; accuracy and methods of accuracy testing; measuring and inspecting all types of tolerances through the definition of the measurement protocol, the configuration and calibration of measuring sensors; methods of automatic inspection planning and simulation of measurement.

learning outcomes

After successfully completion of this course, the students should be capable to: recognize the structure and characteristics of the CMM subsystem with their functions; determine the CMM coordinate systems and define the inspection and measurement plan (determine the sequence of metrological tasks with the configuration of the measurement sensor and perform the analysis from the geometric-metrological aspect); determine the CMM error budget and perform its analysis; take tolerances from the CAD geometric model, simulate measurement and output from the simulation used in the CMM programming system (geometric-metrological identification); analyze the report on the results of measurement and inspection; make CMM selection for the conditions of use (group of metrology tasks) in the production organization.

theoretical teaching


practical teaching

Practical teaching embraces ten units: seven auditory and three laboratory exercises, as well as seminar work. The content of the auditory exercises is as follows: 1. Measurement and
inspection. Determination of the coordinate measurement system. 2. Definition of geometric and metrological features. 3. Distribution of measuring points by metrological features depending on the type of tolerance. 4. The principle of the collision avoidance. 5. Generating the initial path of the measurement sensor during inspection of prismatic parts on CMM. 6. Generating the optimal path of the measuring sensor on the base an ants colony optimization technique. 7. Analysis of setup of measuring parts and measuring bases.

Laboratory exercises are realized by factory visit and work in the PTC-Creo (CMM-module) software for modeling and simulation, as a followed: 1. Visit to the factory that owns CMM and get familiar about its work and technical characteristics. 2. Modeling and simulation of measurements in the software system PTC Creo - CMM module. 3. Inspection planning in PTC Creo - CMM module for a concrete measuring part. Generating CL files of a measuring sensor.

**prerequisite**

Defined by curriculum of study programme.

**learning resources**

1. Handouts for each lecture. 2. The instruction for doing laboratory exercises, tasks and seminar work. 3. The monograph in the field of quality and production metrology (in preparation). 4. The web site of the course with addresses of leading organizations and important institutions in this area (under preparation). 5. Facility and technical equipment: Laboratory for production metrology and TQM.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 14 laboratory exercises: 9 calculation tasks: 3 seminar works: 4 project design: 0 consultations: 0 discussion and workshop: 0 research: 0

**knowledge checks**

check and assessment of calculation tasks: 2 check and assessment of lab reports: 2 check and assessment of seminar works: 2 check and assessment of projects: 0 colloquium, with assessment: 4 test, with assessment: 0 final exam: 5
assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 20
seminar works: 10
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references

Stojadinovic, S., (2018), Handouts for each lecture.
Stojadinovic, S., Majstorovic, V., The monograph in the field of quality and production metrology (in preparation)
Majstorovic, V., Hodolic, J., Coordinate Measuring Machine, FTN Novi Sad
Sladek, A. J., Coordinate Metrology - Accuracy of Systems and Measurements, Springer Verlag Berlin Heidelberg
Digital system design

ID: MSc-0597  
**responsible/holder professor:** Bučevac M. Zoran  
**teaching professor/s:** Bučevac M. Zoran  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** information technologies  
**semester.position:** 1.5

**goals**

- Introducing with: number systems, Boolean algebra and binary logic, logic functions as well mastery of their usage and manipulation.
- Mastering of: various types of logic circuits-LC and methods for their analysis and design.
- Mastering of handling with integrated digital circuits and oscilloscope.

**learning outcomes**

After the successful completion of the course the student is expected to:  
- In proper way understand the nature of digital computers and processes inside them.  
- In easier way, manipulate with digital computers in hardware and software sense, as a part of digital automatic control systems (DACS).  
- Use the methods necessary for analysis and synthesis of various types of logic circuits (LC).  
- Apply digital computer for solving of computational nature problems in "off line" mode, either related to the analysis or synthesis of LC.  
- Carry out analysis and design of real physical LC.

**theoretical teaching**

- Number systems: definitions; conversion; arithmetic; complements; codes  
- Boolean algebra and binary logic: definitions  
- Logic functions: definition, logic digrams, minimizing  
- Combinational logic circuits: definition, design; arithmetic LC; code converters; analysis  
- Combinational logic circuits with integrated logic circuits: design; adders; magnitude comparator; decoder and demultiplexer; coder and multiplexer; ROM and programmable logic array  
- Synchronous sequential logic circuits: concept; flip flops; analysis; design  
- Asynchronous sequential logic circuits: analysis and design  
- Registers, counters and memory units  
- Algorithmic sequential logic circuits: flow chart; synchronization; design of control block  
- A/D and D/A converters: conversion procedures

**practical teaching**

PA  
Examples:  
- number systems; arithmetic operations  
- Boolean algebra theorems  
- minimizing by map and tabulation methods  
- design and analysis of combinational LC
• analysis and design of synchronous sequential LC
• analysis and design of asynchronous sequential LC
• design of counters, algorithmic sequential LC
• various types of A/D and D/A converters

PL
• Simulation of binary numbers and BCD code
• Physical interpretation of logical operations
• Logic gates
• Combinational LC; code converters
• Design with digital multiplexers
• Flip flops; synchronous and asynchronous sequential LC
• Counters, registers; memory unit; algorithmic sequential LC
• A/D and D/A converters

PZ
• Logic functions and gates, conventional and integrated combinational LC
• Design of synchronous and asynchronous sequential LC

prerequisite
• Basic knowledge of undergraduate calculus.
• Basic knowledge of undergraduate electrotechnics.

learning resources
1. Manuscript at http://au.mas.bg.ac.rs/Nastava-Kau/Nastava_Download.htm, DVL
2. Zoran Bučevac: Laboratory exercises for digital systems, Mechanical engineering faculty, Belgrade 2011, PRA, library and bookstore of MEFB
3. Power supply, oscilloscope, lab. for Digital systems, EOP/LEO
4. Protoboards, integrated circuits, Lab. for Digital systems, EOP/LEO
5. Freeware software, MEFB
6. PCs, Lab. for Digital systems and Computer lab. MEFB

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 12
laboratory exercises: 15
calculation tasks: 3
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0
knowledge checks

- check and assessment of calculation tasks: 3
- check and assessment of lab reports: 1
- check and assessment of seminar works: 0
- check and assessment of projects: 0
- colloquium, with assessment: 5
- test, with assessment: 1
- final exam: 5

assessment of knowledge (maximum number of points - 100)

- feedback during course study: 5
- test/colloquium: 35
- laboratory exercises: 5
- calculation tasks: 25
- seminar works: 0
- project design: 0
- final exam: 30
- requirements to take the exam (number of points): 0

references

M. Morris Mano, Digital design, Prentice-Hall, New Jersey, 1984., KSJ, available in library of MEFB
A. D. Friedman, Fundamentals of logic design and switching, Computer Science Press Inc., Rockville, Maryland, 1986., KCJ
J. B. Peatman, Digital hardware design, McGraw-Hill, N.Y., 1980, KCJ
**Dynamic Systems Simulation and Testing**

**ID:** MSc-0563  
**responsible/holder professor:** Ribar B. Zoran  
**teaching professor/s:** Ribar B. Zoran  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** control engineering  
**semester.position:** 1.5

**goals**

This subject introduce candidate in Matlab Simulink simulation package.  
This subject introduce candidate with examination of static and dynamic characteristics of automatic control systems.  
Candidate will be familiar with identification of dynamic systems.

**learning outcomes**

Introduction in experimental determination of static and dynamic characteristics of automatic control systems.  
Introduction in presentation of various automatic control systems and control systems using program package for simulation of dynamic systems.  
Introduction for verification used mathematical models of dynamic systems by experiment and by use of program package Simulink.

**theoretical teaching**

Simulation of time continuous and time discrete automatic control systems. Simulation of hybrid automatic control systems. Basic elements of program package Simulink necessary for simulation of dynamic systems. Mathematics models of dynamic systems.  
Representation of these models using of programe package Simulink. Verification of the results of simulation. Simulation of linear controllers. Simulation of nonconventional controllers such as variable structure, tracking, fuzzy etc. Step function responses of dynamic systems. Examination of automatic control systems using sinusoidal function. Determination of frequency characteristics. Basic methods for identification of mathematics models of plants by Simulink.

**practical teaching**

Introduction with methods for approximate solving differential equations by use Simulink.  

**prerequisite**

Defined by curriculum of study program.
learning resources


number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 15
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 5
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 30
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references
Electric Machinery

ID: MSc-0401  
responsible/holder professor: Škatarić M. Dobrila  
teaching professor/s: Stojić M. Tomislav, Škatarić M. Dobrila  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written+oral  
parent department: physics and electrical engineering  
semester.position: 1.5

goals

Understanding and accepting basic laws in electric machinery; according to this knowledge students will be able to describe and recognize some important problems in many engineering fields: mechanical engineering, bio-medicine, food processing industry, and power engineering. The students will meet during the course different types of electric machines.

learning outcomes

Upon successful completion of this course, students should be able to:
1) adequately recognize, mathematically describe and understand the most important types of electrical machinery and processes in them;
2) adequate mathematical express and quantify different physical quantities that describe the operation of electrical machines;
3) recognize the need for the application of appropriate electrical machine to the requirements of real engineering problems; define the basic data required to communicate with other professions;
4) recognize on the basis of the acquired knowledge the actual existing electrical drives and perform elementary diagnostics of possible failures of electrical machines.

Checking outcomes listed under items 1) and 2) is done via computational tests and exam, as well as via student answers to the questions.
Checking outcomes cited under 3) and 4) is based on individual problems addressed to each student to be solved.

theoretical teaching

Magnetic circuits: Intro, basic components, permeability and hysteresis.
Transformers: power transformers, autotransformers, measuring transformers; basic equations, measurements, connections.
Electro- mechanical systems; energy conversion principles; force and torque equations.
Dc Machines: motors and generators; basic equations, moment characteristics, efficiency.
Induction motors (3 phase): principles and equations; construction; implementation.
Synchronous machines: types, construction, equations, principle of operation, implementation.
Single phase induction motors: specifics in construction and operation
Step motors: construction and principles of work; implementation.
Control of electric machinery: classical and modern control principles (electronic, frequency, PLC application etc)

practical teaching
Practical lessons include: 1) exercises on the blackboard (numerical examples and problems in general numbers) and 2) labs. Practical classes follow the curriculum of lectures, particularly transformers, polyphase induction motors, motors and direct current generators and a combination of electromechanical coupling. The making of homework is scheduled.

Laboratory exercises are: 1) Measurement power of three-phase motors, 2) Demonstration of a three-phase synchronous generator, 3) Operation of three-phase asynchronous motors: basic quantities measurement, change the direction of rotation; 4) DC motor, regulation, demonstration of work.

**prerequisite**

no specific conditions

**learning resources**

1. Handouts.
4. T.Stojic, D.Skatarić, Electrical machines for mechanical engineering students /in Serbian/, Faculty of Mechanical engineering, Belgrade, 2015.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 20
laboratory exercises: 4
calculation tasks: 4
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 2
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 6
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 40
laboratory exercises: 15
calculation tasks: 10
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Internal combustion engines - M

ID: MSc-0866
responsible/holder professor: Popović J. Slobodan
teaching professor/s: Popović J. Slobodan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: internal combustion engines
semester.position: 1.5

goals

The aims of the course are to provide a comprehensive insight into the subject matter of Internal Combustion Engines (theoretical operating cycle, real operating cycle, engine systems, engine operating characteristics). It is intended for students of the Internal Combustion Engines module as an in-depth introduction into studies of specific areas of Internal Combustion Engines, as well as for students of modules which require knowledge of Internal Combustion Engines as a power unit (Motor vehicles, Naval Architecture, Railway Mechanical Engineering, and Material Handling, Constructions and Logistics).

learning outcomes

Acquired theoretical and practical knowledge of Internal Combustion Engines. The ability to link fundamental engineering branches of thermodynamics, fluid mechanics, mechanics, strength of materials etc. into a complex unit such as engine. The ability of competent approach to engine selection, organization of exploitation and maintenance. Acquisition of solid base for tackling specific problems, design and construction of Internal Combustion Engines.

theoretical teaching

1. Introductory considerations.
3. Engine real operating cycle: gas exchange process.
5. Combustion process in CI Engines.
6. Engine working parameters
7. Engine supercharging.
8. Engine dynamic problems.
9. Engine operating characteristics.

practical teaching

Auditory exercises:
1. Engine design and Engine slider mechanism characteristics
2. IC Engine working medium, fuel characteristics and combustion
4. Fuel supply systems for SI and CI Engines.
5. Numerical examples in IC Engine working parameters, engine charging and heat balance.
6. Numerical examples in IC Engine supercharging
7. and Numerical examples of IC Engine slider mechanism kinematics and dynamics.
8. Engine systems and devices: ignition system, starting system, cooling system – air-cooled and liquid-cooled engines, lubricating system.
9. Numerical examples in IC Engine operating characteristics
10. Fundamentals of engine testing and preparation of laboratory exercises for engine testing.

Laboratory exercises:
1. Fuel supply systems for SI and CI Engines and engine electrical systems.
2. Testing of engine characteristics on the test bench.

**prerequisite**

No prerequisites required.

**learning resources**

2. M. Tomić & S. Popović: Lecture notes (handouts) - Basics of Internal Combustion Engines, available in e-form in pdf on the site of the Chair of Internal Combustion Engines
3. IC Engine testing Laboratory (with an engine on the test bed)
5. National Instruments LabView

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 9
laboratory exercises: 10
calculation tasks: 7
seminar works: 0
project design: 0
consultations: 4
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 5
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 3
final exam: 5
assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
Test/colloquium: 15
laboratory exercises: 10
calculation tasks: 25
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

references

Maintenance of Machinery and Equipment

ID: MSc-1141  
responsible/holder professor: Vasić M. Branko  
teaching professor/s: Vasić M. Branko, Popović M. Vladimir  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written+oral  
parent department: motor vehicles  
semester.position: 1.5

goals

Managing Machine and Equipment Maintenance as part of Asset Management (Asset Management) is a systematic process of planning, maintaining and operating viable physical assets during their useful (economic) lifetime, in order to achieve current and future optimal benefits for all stakeholders in the community.

The effective management of assets is becoming increasingly important to organizations and their interested parties. In order to share the latest thinking, processes, methods and tools in joined up management of any types of asset, this comprehensive one semester course provides techniques and methods for students to explore the organizational implications of the:

International standard for Asset Management with focus on:  
- What is Asset management and why it is important to an organization  
- The benefits of a management system for asset management  
- The key terms, concepts and principles of ISO 55001:2014  
- The main requirements of ISO 55001:2014  
- Maintenance KPI Key Performance Indicators

Then, with the system of the indicators with focus on:  
- economical, technical and organisational  
- Methodology for selection and use of key performance indicators for maintenance

and project management and organization of the maintenance system, through:  
- An Overview of Key Project Management Concept  
- Initiating the Project  
- Identifying the Work  
- Estimating the Work  
- Scheduling the Work  
- Creating the Budget

learning outcomes

Upon this comprehensive one semester course, students will be able to:  
- Recognize and be able to apply asset management terminology, definitions and principles  
- Identify and manage the expectations of stakeholders with respect to asset management  
- Become familiar with internationally recognized asset management methodologies and good practices  
- Apply structured approaches available for the improvement of value realization from assets  
- Recognize the value obtainable from the integrated approach to the life cycle and
risk-based management of assets
- Understand what Maintenance is doing
- How maintenance should be measured
- What maintenance is achieving for the business and
- What more it can do to improve operational performance
- Ensure that projects are set-up for success from the start
- Understand the role of the project manager, business analyst, and others in managing projects
- Develop an integrated project plan including realistic scope, schedules, budgets, and risks
- Learn how to effectively track and report on project progress

theoretical teaching

Theoretical part of the course is divided into four blocks, consisting of four thematic units with a total fond of $4 \times 5 = 20$ h, $4 \times 2.5 = 10$ hrs to develop the lecture and master the new material.
The basic teaching blocks include the following areas:
- Asset Management concept and requirements of international standards,
- Machinery maintenance strategies as a key asset management segment,
- Basics of project management,
- Key performance maintenance indicators

practical teaching

The course content also includes practical lessons. The entire class is divided into four blocks-
- Auditory classes are followed by lectures. Practical classes are realized through 15 hours of exercises and 15 hours of independent student work (computing tasks and seminar work). A total of 15 hours are foreseen for checking knowledge, out of which 10 for partial knowledge tests and 5 for final examination of knowledge. The four basic teachers include the following areas:
- Asset Management concept and requirements of international standards,
- Machinery maintenance strategies as a key asset management segment,
- Basics of project management,
- Key performance maintenance indicators.

prerequisite

Defined by curriculum of module for motor vehicles.

learning resources

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 15
laboratory exercises: 0
calculation tasks: 5
seminar works: 10
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 3
check and assessment of lab reports: 0
check and assessment of seminar works: 7
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 25
seminar works: 35
project design: 0
final exam: 30
requirements to take the exam (number of points): 40

references
Management Information Systems

ID: MSc-0523  
responsible/holder professor: Misita Ž. Mirjana  
teaching professor/s: Misita Ž. Mirjana  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: oral  
parent department: industrial engineering  
semester.position: 1.5

goals

The aim of this course is to introduce students to contemporary theoretical and practical aspects of management information systems. Students need to acquire practical knowledge and skills that will enable them to enhance the quality of decisions in the field of industrial engineering, by using the contemporary software tools. Decision support systems and expert systems.

learning outcomes

Upon successful completion of this course, students should be able to:
- Use software tools for decision support,
- Design models for decision-making process in DSS tools,
- Using expert systems in the field of industrial engineering,
- Projected base of knowledge in expert systems,
- Estimates of efficiency designed models in the specific case study.

theoretical teaching


practical teaching

Task 1. By using software tools - decision support systems it is necessary to design models, generate a hierarchy of criteria and alternatives by introducing of qualitative and quantitative scales, introducing uncertainty, or by using functions to describe real problems in manufacturing practices. Conduct ranking according to the AHP or SMART methods. Sensitivity Analysis. Presentation of project assignment.

Task 2. By using an expert system shell it is necessary to design a knowledge base for the real engineering problem, link the production rules. Test the expert system. Presentation of project assignment.

Task 3. Connect the two previous project tasks and form a hybrid system. Presentation of project assignment.

prerequisite

Enrolled 1st semester of the Master study.
learning resources

1. Book: Milanovic D. Dragan, Misita Mirjana, Information systems for management and decision making, Faculty of Mechanical Engineering, Belgrade, 2008.
2. Handouts,
3. Computer classroom,
4. Software packages: decision support system and expert system.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 40
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 5
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 50
requirements to take the exam (number of points): 10

references
Milanovic D. Dragan, Misita Mirjana, Information systems for management and decision making, Faculty of Mechanical Engineering, Belgrade, 2008
Nuclear Reactors

ID: MSc-0345
responsible/holder professor: Stevanović D. Vladimir

Teaching professor/s: Milivojević S. Sanja, Stevanović D. Vladimir

Level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6

Final exam: written+oral

Parent department: thermal power engineering
Semester.position: 1.5

Goals

The aims of the subject are acquiring academic knowledge about processes and equipment for nuclear energy utilization, about neutron processes and fission, principles of nuclear reactors design, reactor core cooling, nuclear fuel characteristics, transport and storage of nuclear waste, nuclear reactors safety, nuclear accidents in Nuclear Power Plants Three Mile Island, Chernobyl and Fukushima, as well as current nuclear reactors developments.

Learning outcomes

Students are able to design nuclear reactor core, determine the thermal and neutron characteristics of nuclear fuel, moderator and reactor coolant, define basic elements of nuclear power plant safety and determine basic technical, technological, ecological and economic conditions and boundaries for the application of nuclear energy.

Theoretical teaching


Practical teaching

The students solve the problems related to nuclear reactors design and analyses of its operation conditions. The numerical experiments are performed with the computer simulations of nuclear reactor processes: calculation of the radioactive chain decay, neutron life cycle and reactor equation solving for various types of nuclear reactors, the model development and computer simulation of the loss-of-feedwater accident in a plant with the pressurized water reactor.

Prerequisite

Passed exams in Physics, Thermodynamics, Numerical methods.

Learning resources

Course handouts.
Ristic, M., Nuclear Reactors, Faculty of Mechanical Engineering, Belgrade, 1969.
Computer equipment.
Software for numerical solving systems of differential equations.
Software for the design of nuclear reactor core.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 5
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 35
laboratory exercises: 30
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**
Numerical simulation of IC Engines processes - Basic approach

ID: MSc-0867
responsible/holder professor: Popović J. Slobodan
teaching professor/s: Popović J. Slobodan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: internal combustion engines
semester.position: 1.5

goals

Acquiring new knowledge on role and importance of modelling dynamic processes in IC Engines. Broadening theoretical knowledge and analytical approach to thermodynamics, heat and mass transfer, fluid mechanics and fuel combustion by studying dynamic processes in IC Engine cylinder and collectors. Broadening knowledge and skills in applied computational methods and modular programming. Developing practical skills to design complex model structures and apply extensive and efficient numerical methods for studying and research of IC Engine dynamic processes.

learning outcomes


theoretical teaching

1. Introduction to IC Engines processes modelling. Importance of mathematical modeling and computer simulation of engine working process for engine design optimization and improving of engine performances, energetic and ecological characteristics.
2. Basic model setup. Zero-dimensional model of real working cycle for engine cylinder as open thermodynamical system - equation setup based on first and second lows of thermodynamic and low of mass conservation. Basic sub-model structure.
3. Modeling of heat transfer to cylinder walls. Theoretical fundamentals and basic equations for the evaluation of heat transfer coefficient.
7. Flow in intake and exhaust plenums and pipes. Boundary conditions. Some methods to numerical solution of basic 1-D model.
8. Engine dynamics. Moment of inertia of reciprocating and rotating masses. Lumped mass
model.
10. Advanced topics in simulation of IC Engine processes. Multi-zone models. Quasi-
dimensional and multi-dimensional models. In-cylinder pressure measurement and model
based combustion analysis.

**practical teaching**

1. IC Engine working process simulation model - basic components and sub-models
2. Basic approach in IC Engine model development: example of single-cylinder engine model;
3. Simulacijà високопритисног дела циклуса без сагоревања;
4. Heat transfer model - examples of basic sub-models development and their application;
5. Thermodynamic properties of working fluid- examples of basic sub-models development
and their application;
6. Modelling flow through valves and ports
7. Heat release basic models - examples and application and comparative analysis;
8. 1-D flow models in pipes and plenums - basic approach and application;
9. Integration of sub-models;
10. Development of engine low-level simulation models using model libraries
11. Mechanical losses in IC Engines - basic empirical models and application;
12. High-level models application - example of two-zone model;
13. High-level models application - example of quasidimensional model.

**prerequisite**

Good practical knowledge of Matlab/Simulink

**learning resources**

Mathworks Matlab/Simulink IDE (Licenced)
Ricardo WAVE – 1D Engine and gas dynamics simulation software package (Licenced)
LMS Imagine.Lab AMESim – Simulation software for modelling and analysis of 1D systems
(Licenced)
Laboratories equipped with IC Engine testing equipment (fully equipped IC Engine test
benches)
DAQ Measurement equipment (National Instruments PXI based system with Labview
Development software)

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 4
laboratory exercises: 12
calculation tasks: 10
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 2
research: 0

**knowledge checks**

check and assessment of calculation tasks: 8
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 2
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 50
seminar works: 0
project design: 20
final exam: 30
requirements to take the exam (number of points): 30

**references**

Pumps and fans

**ID:** MSc-0446  
**responsible/holder professor:** Nedeljković S. Miloš  
**teaching professor/s:** Nedeljković S. Miloš, Čantrak S. Đorđe  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** hydropower engineering  
**semester.position:** 1.5

**goals**
Mastering knowledge of engineering applications of pumps and fans as machines for raising of fluid energy. Capacity to work in practice on energy installations, as well as design of installations that include a pump or blower as a built-in element with its function.

**learning outcomes**
After finishing this course, the students should be able to:
1. Know and recognize the types and designs of pumps and fans,
2. Calculate the pump/fan/system energy parameters and energy balancing,
3. Calculate and apply the dimensionless parameters - characteristic performance factors,
4. Determine the pump/fan/system working point,
5. Apply the energy characteristics of pumps/fans for establishment of operating regimes, as well as in their regulation,
6. Calculate the pump and the system cavitation characteristics,
7. Calculate the change of fan operating characteristics when working with density other than air.

**theoretical teaching**

**practical teaching**
various plants. Piston pumps - principles of work. Demonstrative laboratory exercises: Institute (laboratory) for hydraulic machinery - showing PF constructions and description of the role of individual parts. PF installations and description of their work.

**prerequisite**

The Fluid Mechanics B exam obligatory passed. Desirable that the student has passed the examination of the subject Introduction to Energy Engineering.

**learning resources**


**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 26
laboratory exercises: 2
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 10
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 70
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 21

references
Sheet-Metal Processing Tools

ID: MSc-0322
responsible/holder professor: Tanović M. Ljubodrag
teaching professor/s: Tanović M. Ljubodrag
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: production engineering
semester.position: 1.5

goals

Acquisition of theoretical and practical knowledge in the domain of the design, calculations and construction of tools for sheet-metal processing by punching, drilling, bending, drawing, and combination of these methods. The student acquires a sound understanding of the importance of team work and cooperation in the area of the design based on contemporary technologies and optimal solution.

learning outcomes

On successful completion of the course, students should be able to:
• Evaluate each element of the tool for its construction and function with respect to the material and performance.
• Identify different concepts of cutting sheet-metal plates, strips and work-pieces, and perform computations for metal efficiency level, which enables students to also understand economic indicators.
• Identify different concepts and specificities of sheet-metal processing tools.
• Create a concept of a sheet-metal processing tool for a specified part.

theoretical teaching


practical teaching

During laboratory exercises the student is acquainted with practical realization of sheet-metal processing tools. Project design for a concrete practice-related work-piece. Tools for making normal-accuracy components. Single-operating, multiple-operating and combined tools. Tools for making ribs for smaller or larger hole shaping. The hole enlargement by edge drawing. A visit to the factory where students are acquainted with the tool making technological process. Acquainting students with recommendations from practice relevant to tool design.

prerequisite
Defined by the Study Program Curriculum

**learning resources**

1. Standardized tool elements, Sheet-metal processing tool elements, Lab for FTS, machining processes and tools, ЛПС

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 2
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 14
consultations: 4
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 6
colloquium, with assessment: 0
test, with assessment: 4
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 40
requirements to take the exam (number of points): 30

**references**
Jovičić M., Tanović Lj., TOOLS AND TOOLING FIXTURES - calculations and constructions of sheet-metal processing tools, FME, Belgrade, 2007, КИХ
Ship Structures 1M

ID: MSc-0974
responsible/holder professor: Motok D. Milorad
teaching professor/s: Momčilović V. Nikola, Motok D. Milorad
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: naval systems
semester.position: 1.5

goals

The aims of the course are to explain the requirements that hull structure has to meet, and as a result,
to gain essential understanding of its general conception, to familiarize the student with the hull
structural members to the design details level, to develop student skills to practically apply standard
engineering methods used for steel hull structure scantling definition.

learning outcomes

A thorough knowledge of general concept and structural members of the welded steel ship hull. The
student should be able to practically apply rules for building ships by various classification societies.

theoretical teaching

Theoretical teaching is partially encyclopedic in character. The student becomes familiar with the hull
basic structural members (terminology presented in both Serbian and English), appearance, basic
functions, and loads they undergo during exploitation, method of fabrication, and their versatility and
design, depending on ship type and size, applied framing system and the like. On the other hand, both
basic principles and methodology for hull scantling definition are considered in parallel, first of all, from
the aspect of strength. The history and today’s role of classification societies is considered, their rules
and basic aspects of some direct calculations are explained.

practical teaching

A detailed prominent example is used to explain the procedure of hull structure scantling definition
according to Lloyd’s Register Rules. Within the framework of independent project design the student is
dimensioning the following structural members of midship section using “his own” concrete example of
the ship: plating and the stiffening system of bottom and inner bottom; plating and the
stiffening system of ship sides; plating and the stiffening system of weather and cargo deck; plating and the stiffening system of water-tight bulkheads; pillars in 'tween deck and hold; fore peak structure; after peak structure.

prerequisite

Defined by the Study Program Curriculum

learning resources

[1] Lectures are available in electronic form /In Serbian/
[2] A thorough prominent example of the project
[3] Various classification societies’ rules

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 12
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 14
consultations: 4
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 6
colloquium, with assessment: 0
test, with assessment: 4
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 15
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 50
requirements to take the exam (number of points): 35

**references**

M. Grubisic: Ship structures /In Serbian/, FSB, Zagreb, 1980.
TRANSPORTATION OF FLUIDS BY PIPELINE

ID: MSc-0458
responsible/holder professor: Crnojević Đ. Cvetko
teaching professor/s: Crnojević Đ. Cvetko
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: fluid mechanics
semester.position: 1.5

goals

learning outcomes

theoretical teaching

practical teaching

prerequisite

learning resources

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 25
laboratory exercises: 0
calculation tasks: 0
seminar works: 5
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 10
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)
feedback during course study: 10

test/colloquium: 45

laboratory exercises: 5

calculation tasks: 0

seminar works: 0

project design: 0

final exam: 40

requirements to take the exam (number of points): 20

references
Algorithms and Data Structures

ID: MSc-0390  
responsible/holder professor: Bengin Č. Aleksandar  
teaching professor/s: Bengin Č. Aleksandar, Mitrović B. Časlav  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written  
parent department: information technologies  
semester.position: 2.1

goals

- Basic facts of algorithm theory.  
- Abstract data type and basic implementation.  
- Data structures in mechanical engineering.  
- Using standard algorithms in solving simple problems in mechanical engineering.

learning outcomes

After successful completion of the program provided for in this case the student can:  
- To find data structure to solve the problem.  
- Use data structures and standard algorithms in solving simple problems in mechanical engineering.  
- To find suboptimal algorithm to solve simple problems in mechanical engineering.  
- To use standard algorithms to solve complex problems in mechanical engineering.

theoretical teaching


practical teaching

Workshops with basic examples.

prerequisite

Knowledge of C/C++ languages. Basic knowledge of program design methodology. Fundamentals of software engineering.

learning resources

The necessary software is under the GNU license - free of charge. In LINUX, C/C++ is immediately available. If you use another operating system, C/C++ compiler can be downloaded from the appropriate Web site (see URL).

number of hours

total number of hours: 75
active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 6
laboratory exercises: 13
calculation tasks: 0
seminar works: 15
project design: 3
consultations: 0
discussion and workshop: 3
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 3
check and assessment of projects: 3
colloquium, with assessment: 0
test, with assessment: 4
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 35
laboratory exercises: 0
calculation tasks: 0
seminar works: 15
project design: 15
final exam: 30
requirements to take the exam (number of points): 35

references
Biomaterials in Medicine and Dentistry

ID: MSc-0640
responsible/holder professor: Sedmak S. Aleksandar

level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral

goals

Introducing students to the application of different biomaterials, previously discussed during Foundations of Biomaterials course, in order to understand and study functional behaviour of biomaterials in the human body. Analysis of the connections between the biomaterial and the body system, in order to ensure reliable implant operation. The potential co-operation with experts in the field of materials science, dentistry and medicine is allowed, which provides the ability to work in specialized laboratories and clinical facilities.

learning outcomes

By attending this course the student will master the application of biomaterials in medicine and dentistry, using modern scientific methods. Theoretical considerations, laboratory experimental work and the application of numerical analysis using the licensed software for finite element method, enables the synergy of the previously acquired knowledge in physics, materials science, mathematics and mechanics, in order to implement them in engineering practice.

theoretical teaching


practical teaching

Examples of applications of biomaterials in the design, development and exploitation of structures used in medicine and dentistry. Examples and solutions of implants that are made from biomaterials. Experimental Methods In Vitro and In Vivo. Application of analytical and numerical models in the structural integrity assurance of biomaterials. Development of a model using the finite element method. Calculation examples considering problems in designing connecting surfaces in biomaterial structures. Application of configuration forces method to prevent failure of the biomaterials structures.
required: Biomaterials Basics; desirable: Basics of biomedical engineering and Biophysics

learning resources

[1] Written lessons from lectures (handouts)

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 8
calculation tasks: 5
seminar works: 0
project design: 4
consultations: 3
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 3
check and assessment of seminar works: 0
check and assessment of projects: 4
colloquium, with assessment: 2
test, with assessment: 1
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 30
requirements to take the exam (number of points): 40

references
Bionics in Design

ID: MSc-1080
responsible/holder professor: Bengin Č. Aleksandar
teaching professor/s: Bengin Č. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 2
final exam: project design
parent department: aerospace engineering
semester.position: 2.1

goals

Introducing students to the process and the procedure of synthesis (create) a combination of mechanical systems engineering design (design) and industrial and bionic design. Besides, the goal of this course is to develop creative skills of students in the design of machines. Understanding the methodology and procedures to create innovative mechanical system through the phase of designing, selection of parameters, dimensions and shape of machine parts, alignment features (functional and aesthetic) with the environment, living and working environment.

learning outcomes

The student is introduced to the procedure of abstract thinking and creative idea generation, the development methodology of the new principal, conceptual, based on bionic solutions. Dressed in designing machine parts and assemblies based on bionic principles, functional, technological, aesthetic, ergonomic, and others. Trained to implement budgets for the mutual adjustment of parameters of machine parts with the limitations, the development of forms and sizes.

theoretical teaching


practical teaching

Influences Leonardo da Vinci, Sir George Cayley, Otto Lilienthal, Gustave Eiffel, Raoul France and Graf von Zeppelin. Bio-strategy application process in fulfilling the spirit of laws rules of biological evolution, which should translate into an acceptable technical solution. Ten basic principles of natural structures. Implementation bionic humanoid proportions and impact on the ergonomic design. Some typical relations (numbers) that characterize the specific effects of similarity and scaling in nature. Bionic Design - views and role models. Wood, vegetable

**prerequisite**

No special requirements

**learning resources**

Laboratory for Design in Mechanical Engineering, Books, Werner Nachtgall, Biologisches Design, Springer-Verlag Berlin Heidelberg 2005, include necessary material for lectures, exercises, assignments, projects and term papers. Require additional materials (handouts, setting assignments, term papers, etc..) Are given at the web site or reproduced on paper. Large-scale electronic materials can be made available to students in direct contact.

**number of hours**

total number of hours: 30

**active teaching (theoretical)**

lectures: 10

**active teaching (practical)**

auditory exercises: 4
laboratory exercises: 0
calculation tasks: 0
seminar works: 4
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 15
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 55
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Computational Aerodynamics

ID: MSc-1078

responsible/holder professor: Simonović M. Aleksandar

Teaching professor/s: Bengin Č. Aleksandar, Peković M. Ognjen, Svorcan M. Jelena, Simonović M. Aleksandar

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: project design

parent department: aerospace engineering

semester.position: 2.1

goals

The goal of the course is to train students in modeling flow problems. After attending the course, finishing all exercises and giving the final presentation, students should be able to recognize the type of the problem, formulate necessary boundary and initial conditions, choose an appropriate discretization scheme and write a program for calculating flow inside or around simpler geometric shapes, such as a nozzle or an airfoil.

learning outcomes

By successfully adopting the program of the course, a student: acquires theoretical knowledge sufficient to recognize the type of the problem as well as the type and number of additional conditions necessary to completely and uniquely define the problem that is being simulated; recognizes basic approximation schemes of the typical problems; masters the principles and foundations of programming related to simulations of continuum; observes the structure of the simulation software that consists of pre-processing, simulation and visualization.

theoretical teaching


practical teaching

Practical training accompanies materials presented during theoretical lectures. In the beginning, students are registered and they familiarize with working in Linux operating system. After that, illustrative examples are completely presented starting with the problem formulation, presentation of the appropriate equations and their approximation, stability and convergence studies, code and reading of the necessary input data, finishing with presenting solutions graphically. Students solve their homework independently and present it to their colleagues.
prerequisite

Defined by the curriculum of the study program/module.

learning resources

1. KPN
2. KLR
3. MPI software

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 5
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 10
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 15
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 55
final exam: 30
requirements to take the exam (number of points): 25

references
Petrović Z. Stupar S., Computer design, Faculty of Mechanical Engineering, 1992, KPN (in Serbian)
Designing agricultural machines and equipment

ID: MSc-0616  
responsible/holder professor: Marković D. Dragan  
teaching professor/s: Simonović D. Vojislav  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written  
parent department: agricultural engineering  
semester.position: 2.1

goals

1. Achieving competence and academic knowledge relating to agricultural machinery and equipment. 2. Mastery of specific and practical skills for carrying out of agricultural machines and equipment. 3. Findings to a multidisciplinary approach to achieve optimal results in the design of agricultural machines and equipment.

learning outcomes

After successful completion of this course, studenty should be able to:
• Define the project management plan,
• Define the forces and moments that are plaguing the machines,
• Calculation of pressure and dynamic load of agricultural machinery and equipment,
• master the methods and processes of agricultural machines and equipment,
• Estimates of the outcomes of the project in relation to the initial request,
• Be efficient in teamwork.

theoretical teaching

1. Technical and economic requirements in the design of agricultural machines and equipment. 2. The theory of cutting tillage. 3. The forces acting on the plugging of the body. The stability of the plow. 4. The main parameters of working elements and machines for additional processing of land. Design of machinery with an active working elements. Disc machines with working elements. Conceptions of cultivators, harrows and rollers. The main parameters and design machines to perform several tasks in one pass. 5. Characteristics and design of machinery for fertilizing, seeding and planting. 6. Machines for chemical pesticides and irrigation equipment. 7. Designing machines to harvest the yields.

practical teaching


prerequisite
Passed exams in 7 semesters (defined curriculum study program/module) and passed items 1.1.5, 1.2.5 of the module IBS

**learning resources**

2. Laboratory installation for profiling working surface plow body, instructions.
4. Veljić, M.: Instructions for making assignments for the design of the working surface plow body.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 4
calculation tasks: 4
seminar works: 0
project design: 10
consultations: 2
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 2
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 4
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 10
laboratory exercises: 10
calculation tasks: 10
seminar works: 0
project design: 30
final exam: 30
requirements to take the exam (number of points): 50

**references**
Gligoric R., Mechanisms of agricultural machinery with the settlement tasks, PF, Novi Sad, 2005.
Urosevic M., Machinery and apparatus for the application of pesticides, PF, Belgrade, 2001.
Martinov M., Markovic D., Machinery and tools for soil cultivation, the first part, FTN, Novi Sad, 2002.
Engineering Condition Monitoring

ID: MSc-0989
responsible/holder professor: Šiniković B. Goran
teaching professor/s: Šiniković B. Goran
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: theory of mechanisms and machines
semester.position: 2.1

goals

Students are to acquire necessary knowledge to trouble-shoot the machinery, reveal main cause of malfunction and prescribe remedial action. Introduction of equipment and devices for engineering diagnosis and skills development for applying them.

learning outcomes

In this course students prepare to accumulate engineering knowledge and skill to approach an object, use the technical documentation to understand system operation, apply appropriate methods of check out, collect relevant data, compare the the results with ISO proposed norms, make a decision and specify the list of remedial action.

theoretical teaching


practical teaching


prerequisite

No prerequisites

learning resources

A. Veg, G. Sinikovic, Manuscript "Fundamentals of technical diagnosis"
A.Veg, G.Sinikovic, Handbook of vibrodiagnosis
number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 24
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 6
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 8
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 2
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 30
laboratory exercises: 25
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

references
Ergonomic design

ID: MSc-1041
responsible/holder professor: Žunjić G. Aleksandar

level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: written

parent department: industrial engineering
semester.position: 2.1

goals

Students should acquire specific practical skills that include an integrated ergonomic approach for the design of a comprehensive solution to different problems. The aim of this course is the acquisition of basic academic knowledge in the field of ergonomic design, which can be used for design of different products, as well as for redesigning and improvement on the system man - machine.

learning outcomes

Upon successful completion of this course, students should be able to:

• Identify the different types of errors in the man - machine system and to apply adequate solutions aimed at eliminating of errors
• Design the indicators based on the application of ergonomic recommendations
• Design the controls based on the application of ergonomic recommendations
• Apply the ergonomic principles and recommendations on the design of the working environment and to conduct an assessment of the working conditions based on the application of experimental procedures
• Recognize the benefits and learn about the possibilities of applying software intended for computer-aided ergonomic design
• Apply the anthropometry in designing various products and transportation systems
• Perform ergonomic assessment of an interface
• Understand and recognize the ergonomic characteristics of the quality of products
• Identify the factors that affect the comfort and safety of a vehicle from the ergonomic aspect

theoretical teaching


practical teaching

Project task - Anthropometric designing of products. Auditory exercise - Design of cabins of cranes and hoists. Laboratory exercise - Assessment of design solution of the working environment conditions.

prerequisite

Faculty of Mechanical engineering — course catalog — M.Sc. (graduate) academic studies

217
The necessary condition for attending the course is that the student have enrolled to the appropriate semester.

**learning resources**

Žunjić A, 2016, Script for Ergonomic design, Faculty of Mechanical Engineering, Belgrade. Žunjić A. and Ćulić M., 2007, Practicum for laboratory exercises in industrial ergonomics, Faculty of Mechanical engineering, Belgrade - available in the bookstore and library of the Faculty of Mechanical Engineering. Klarin M. and Žunjić A., 2007, Industrial ergonomics, textbook, Faculty of Mechanical engineering, Belgrade - available in the bookstore and library of the Faculty of Mechanical Engineering. Sound level meter, konimeter, psychrometer, lux meter, anthropometric measuring equipment.

**number of hours**

total number of hours: 45

**active teaching (theoretical)**

lectures: 18

**active teaching (practical)**

auditory exercises: 2
laboratory exercises: 8
calculation tasks: 0
seminar works: 0
project design: 8
consultations: 3
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 1
colloquium, with assessment: 0
test, with assessment: 0
final exam: 3

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 40
requirements to take the exam (number of points): 40
references

Fire Control Systems

ID: MSc-0111
responsible/holder professor: Milinović P. Momčilo
teaching professor/s: Milinović P. Momčilo
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 2
final exam: oral
parent department: weapon systems
semester.position: 2.1

goals

Goal of subject is orientated to the student knowledge about basic technologies integrated in the battle that provides precise engagement and reliable shooting of target by direct, indirect or other type of weapon fire. Modern systems employed and design by the basic knowledge about LOS, NLOS, and other shooting elements and principles understand sensor principles, automatic devices and software proceedings, based on ballistic shooting elements. Modern navigation and position principles of weapon fire represented by fundamental vectoral battle mechanics, of platforms motion, targets and projectiles flight in FCS composition models. Processes are represented by artillery, AD, BMD, and armored vehicles battle mechanics and platforms and units integrated systems.

learning outcomes

Student is trained and educated to solve individual employment of weapon and their integrations of performances with other non weapon helping defense equipment and battle functions. Those understand shooting functions precision positioning and errors estimation, preparing weapon for selected target mission, and ballistics and flight mechanics estimation for optimal target shooting. Also student achieve basic knowledge for Command information battle technology and weapon fire precision strike technology. Software, autoimmunization and mechatronics sensor integration, in the battlefield mechanics of unsteady state vectoral proposals provides FCS software and hardware knowledge, for weapon designers.

theoretical teaching

1. Ballistic trajectories in shooting principles for LOS and NLOS projectiles and types of weapon fire.
2. Conventional indirect fire artillery shooting and FCS.
3. Shooting artillery of armored vehicles in motion and direct fire autoimmunization stabilization and errors estimations. Devices and equipment of weapon stabilization and equipment for FCS
4. Air defense gun systems and AD combat platforms and AD responsibilities areas
5 Sensors, tracking targets equipment, sighting, automatic optoelectronics, and IR technology laser range finders and navigation GIS and GPS systems and errors performances and analyzes.

practical teaching

1. Examples of trajectories and corresponding tactical weapon type.
2. Armored vehicles and tank weapons stabilization and shooting FCS integration
3. Automatic control principles for tracking and shooting for air defense platforms and
systems / gun and missiles

1.4. UAV and navigating principles of GIS and GPS precision strike on the target, and new concepts of C2I, C3I, C4I, C4ISTAR, in command and control FCS navigation

**prerequisite**

Finished and signed seminar paper.

**learning resources**

M.Milinovic: Contemporary problems of fire control systems in AD defense. University of Belgrade Faculty of ME, Belgrade, monograph.
M.Milinovic: Fire control system dynamics (serb), University of Belgrade Faculty of ME, Belgrade, textbook.

**number of hours**

total number of hours: 30

**active teaching (theoretical)**

lectures: 12

**active teaching (practical)**

auditory exercises: 12
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 1
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35
references

Eugene L. Fleeman, Tactical Missile Design, 2001 AIAA, USA
Robert L. McCoy, Modern Exterior Ballistics, 1999 AIAA, USA
Fuzzy Control Systems

ID: MSc-0642
responsible/holder professor: Jovanović Ž. Radiša
teaching professor/s: Jovanović Ž. Radiša
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: control engineering
semester.position: 2.1

goals

• Understanding of fuzzy approach to modeling phenomenon, process and systems
• Introduction to basic of fuzzy set theory and fuzzy control theory
• Introduce students to the fundamental principles of artificial neural networks
• Analysis, design, simulation and practical realization of fuzzy control systems using Matlab/Simulink and LabView programming software.

learning outcomes

Knowledge and understanding of:
• Fuzzy set, fuzzy logic and fuzzy control theory
• Design of fuzzy controllers and fuzzy systems
• Synthesis of various fuzzy control algorithms
• Simulation and practical realization of fuzzy control systems using PC and programing software Matlab/Simulink and LabView.

theoretical teaching


practical teaching

PA:
Practical work includes computational exercises that follow the content of course.

PL:
Practice and experiments: simulation and experimental application of fuzzy algorithms as well as their practical realization using Matlab and LabView for control different plants within a modular educational real-time control system (inverted pendulum, , heat flow experiment, DC servo motor).

prerequisite

Defined by curriculum of the study programme.
learning resources

• Radiša Jovanović, Fuzzy control systems, Lecture notes in electronic form,
• Radiša Jovanović, Matlab and Simulink in Automatic Control, Faculty of Mechanical Engineering, Belgrade, 2016.
• Modular educational real time control system with various control plants (DC servo motor, inverted pendulum, double inverted pendulum, heat flow experiment, coupled water tanks experiment), with acquisition hardware and software,
• Electrohydraulic control system,
• PC and PC Embedded controllers, Siemens Simatic PLC, National Instruments controllers,
• Installation for control system testing and acquisition of electrical variables,
• Automatic Control Laboratory, Intelligent Control Systems Laboratory, Control Systems Laboratory.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 5
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 4
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 50
laboratory exercises: 5
calculation tasks: 10
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references

K. M. Passino, S. Yurkovich, "Fuzzy Control", Addison-Wesley, 1998
Heat transfer operations and equipment

**ID:** MSc-1057  
**responsible/holder professor:** Genić B. Srbislav  
**teaching professor/s:** Genić B. Srbislav  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** process and environmental protection engineering  
**semester.position:** 2.1

**goals**

Analysis of the mass transfer operations and apparatuses and assessment of their role in modern industry.  
Understanding the most commonly used types of mass transfer apparatuses - their design and calculation procedures.

**learning outcomes**

The mastery of calculation procedures needed to analyze the mass transfer operations - the material balance, determination of the operational line and driving force.  
The mastery of calculation procedures for sizing of the most commonly used mass transfer apparatuses.

**theoretical teaching**

Classification of mass transfer operations and basics principles of mass-transfer operations  
General calculation procedure for mass transfer operations. Operation and equilibrium line, mass transfer driving force, number of transfer units, theoretical stage.  
Mass transfer operations: distillation (continuous evaporation, single stage distillation, continuous condensation, distillation with deflegmation, differential distillation, fractional distillation, differential condensation), rectification, absorption, extraction, leaching, adsorption, drying.  
Mass transfer apparatuses for gas-liquid systems, liquid-liquid and solid phase - fluid. Trayed and packed columns, drying chambers, etc.  
Membrane mass transfer operations and and apparatuses.  
Development trends in the field of mass transfer operations and apparatuses.

**practical teaching**

Examples of mass transfer operations. Mass and heat balancing. Determination of the operating line, driving force, the number of transfer units, the number of theoretical stages.  
Examples of sizing of most commonly used mass transfer apparatuses: distillation column (with packing and with trays), extraction columns (with packing and with trays), adsorber (with a fixed layer of adsorbent), dryers (continuous and periodical).  
Design procedures for membrane mass transfer operations and and apparatuses.

**prerequisite**

Defined in curriculum of the study program of the module.

**learning resources**

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 16

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 3
calculation tasks: 0
seminar works: 0
project design: 16
consultations: 6
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 3
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 6
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 30
requirements to take the exam (number of points): 0

**references**
Hydraulic turbines

ID: MSc-0808
responsible(holder) professor: Božić O. Ivan
teaching professor/s: Božić O. Ivan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: hydropower engineering
semester.position: 2.1

goals

Achieving academic competence in the fields of hydraulic turbines and hydropower. Mastering theoretical knowledge of flow process through the turbines and energy transformation therein (fluid and mechanical system interaction). Obtaining practical knowledge in optimal energy and cavitation performances calculation of hydraulic turbines. Having the relevant know-how for the turbine industry, design companies and power plants.

learning outcomes

On successful completion of this course the students will be able to:
- recognize different types and constructions of hydraulic turbines,
- describe the principles of operation, explain and analyze fluid flow in various hydraulic turbines,
- define, calculate and analyze the specific geometry, energy and cavitation parameters of hydraulic turbines,
- construct the essential components and explain their roles from the point of the optimal energy transfer process in various hydraulic turbines,
- design and choose the optimal type and geometry of hydraulic turbines flow passages with the aim of high efficiency operation of hydropower plants,
- define, analyze and apply universal characteristics and operational hill charts for hydraulic turbines, and their scale up (model to prototype).

theoretical teaching


practical teaching

Auditory exercises and calculation examples:
Hydropower plants operation fundamentals. Historical development, classification, properties and application of turbines. Determination of basic and main parameters (gross and net head,
discharge, power, efficiency, hydraulic and mechanical power losses, rotational speed).
Application of Euler's equations for the turbine. Determination of velocity triangles, relation
between specific energies of turbine unit and runner, degree of reaction and hydraulic axial
force. Determination of unit and specific turbine parameters. Scale-up of turbine model
hydraulic efficiency characteristics and cavitation coefficient to a turbine prototype.
Determination of suction height. Determination of universal and operation (hillchart) turbine
characteristics. Cam curve determination. Construction of Pelton, Francis, Kaplan and bulb
turbine. Choice and calculation of the spiral cases, stators, guide vanes and draft tubes of
Explanatory exercises in the laboratory for hydraulic machines and energy systems, and
numerical simulations:
Presentation of hydraulic turbine constructions and description of a particular turbine
passage function. Installations for testing hydraulic turbines and description of their
operation. Presentation of numerical experiment - the turbine flow calculation using the
contemporary CFD techniques.
Project (carrying out the project based on instructions): Choice of turbine and calculation of
its basic dimensions in accordance with the given input parameters.

prerequisite
Defined in the Curriculum

learning resources
Božić, I.: Hydraulic Turbines - Practical examples with extracts from theory, University of
Belgrade Faculty of Mechanical Engineering in Belgrade, 2017
Božić, I.: Auditory exercises handouts
Laboratory hydraulic machines and energy systems - devices, installations for testing
turbines, measuring equipment and exhibits
Faculty Computer Classroom

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 4
calculation tasks: 9
seminar works: 0
project design: 5
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks
check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)
feedback during course study: 5
test/colloquium: 40
laboratory exercises: 0
calculation tasks: 0
seminar works: 25
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Мирослав Бенишек „Хидрауличне турбине“, Машински факултет у Београду, 1998
Иван Божић „Хидрауличне турбине - Практични примери са изводима из теорије“, Машински факултет у Београду, 2017
Берлит В „Гидровлические турбине“, Головное издательство „Виша школа“, Киев, 1977
Ковалев Н, „Справочник по гидротурбинам“, Машиностроение, Ленинград, 1984
Raabe J, „Hydropower“, VDI Verlag, GmbH, Düsseldorf, 1985
IC Engine Design 1

ID: MSc-1087
responsible/holder professor: Knežević M. Dragan
teaching professor/s: Knežević M. Dragan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: internal combustion engines
semester.position: 2.1

goals

The aims of the course are to provide theoretical and practical study about engine dynamics, vibrations and design of engine parts. Through the evaluation of engine kinematics, dynamics and engine parts mechanical load and stress students acquires a sense for design of engine parts and complete engine. Basic knowledge about 3D modeling of engine parts and stress calculation using FEM is also provided and enable modern approach to engine design.

learning outcomes

The merger of theoretical knowledge of mechanics, basics of strength of constructions and machine elements and its applications on engine design. Training students for engine parts and systems design, modeling and calculation. The acquisition of basic theoretical and practical knowledge required for complete engine designing.

theoretical teaching


practical teaching

1. Forces of engine piston mechanism; crankshaft tangential force and the variations of engine torque and crankshaft rotational speed, the role and calculation of engine flywheel; instructions for engine kinematics and dynamics calculation. 2. Examples of engine parts design and thermal and mechanical stress calculation; instructions for mechanical calculation of piston group, connecting rod and crankshaft. 3. The application of 3-D modeling in engine parts design;

prerequisite

No prerequisites required.

learning resources

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 16
laboratory exercises: 0
calculation tasks: 4
seminar works: 0
project design: 7
consultations: 3
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 2
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 3
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 15
laboratory exercises: 0
calculation tasks: 15
seminar works: 0
project design: 30
final exam: 40
requirements to take the exam (number of points): 30

**references**
M.C. Živković: Internal combustion engines, part 2. Engine design 1, Kinematics and dynamics of piston mechanism. Faculty of Mech. Eng., Belgrade, 1983
M.C. Živković, R. Trifunović: Internal combustion engines, part 2. Engine design
Köhler, E., Flierl, R: Verbrennungsmotoren: Motormechanik, Berechnung und Auslegung des Hubkolbenmotors
Industrial logistic

**ID:** MSc-0416  
**responsible/holder professor:** Petrović B. Dušan  
**teaching professor/s:** Petrović B. Dušan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** industrial engineering  
**semester.position:** 2.1

**goals**

Achieving competency and academic skills in the process of industrial system design. Special emphasis is focused on development of creative skills and overwhelm with specific practical skills needed for professional practice using operational research methods, procedures of analysis and synthesis for obtaining final goal which is optimal practical solution.

**learning outcomes**

Curriculum overcome enables converge of the following skills: analysis, synthesis and prediction of solutions in design process based on knowledge applying in practice using professional ethics as well as development of crucial and self-critical thinking and approach.

**theoretical teaching**

Logistic system in industrial environment (role of logistic system in industry, functions which system must achieved and its benefit for industry). Elements of logistic system (production based on end user demand, distribution and warehouse systems). Basic sub-systems of logistic system (production with defined capacity, transport with defined technology and distribution warehouse system). Place and role of the warehouse in logistic system. Application and effects of application of logistic systems in industry (territory coverage with defining location of production and end user, reduction of transport and storage costs and increase of flexibility towards end user).

**practical teaching**

Audit lessons (Introduction in design process for defined logistic system – defining elements of logistic system and basic sub-systems for chosen logistic system. Introduction in warehouse design of palletized goods – defining of: reception area, main warehouse, distribution – order picking, shipping and warehouse management system).  
Project workmanship (Determining of the optimal location of the logistic system in macro surrounding – positioning of warehouse regarding to production and end user as a function of transport system. Project of warehouse for palletized goods - defining of: packing and capacity, work technology, layout, reception and shipping and warehouse management system).

**prerequisite**

There is no special conditions needed for course attending

**learning resources**
6. Practical instruction in industrial environment.
7. Personal computers.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 5
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 25
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 6
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 40
final exam: 30
requirements to take the exam (number of points): 30

**references**
Locomotive 1

ID: MSc-0243
responsible/holder professor: Lučanin J. Vojkan
teaching professor/s: Lučanin J. Vojkan, Tanasković D. Jovan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: railway mechanical engineering
semester.position: 2.1

goals

1. Introduction student to the basic concepts important for understanding the designing of diesel locomotives.
2. Knowledge acquiring necessary for understanding the designing of diesel locomotives.
3. Competence for use the knowledge acquired in solving practical problems in designing, use and maintenance of diesel locomotives.

learning outcomes

After successfully finishing of course students would be able to:
- define basic characteristics of diesel locomotives;
- describe tasks and way of functioning of assemblies of diesel locomotive;
- compare tractive characteristics of different types of power transmissions;
- calculate the key parameters using special software package;
- implementation of regulations and standards in field of diesel locomotives.

theoretical teaching

Brief history, Overview of historical development and traction vehicles basic characteristics, High speed vehicles, Influential factors on adhesion, Traction force, Resistance during motion, Basic conception of diesel traction vehicles, Introductions with the basic framework, Design of the running bogie and the supporting vehicle structure, Diesel motor - specification of diesel motors for railway vehicles, Power supply characteristics, Modern motors for railway vehicles, Examination and emission of exhaust gases, Characteristics of units for power transmission on railway vehicles, Design of mechanical transmitters, Design of hydrodynamic transmitters, Joint operation of diesel motor and hydrodynamic transmitter, Design of cooling systems.

practical teaching

Practical training, Auditory exercises (Introductions with examples regarding learned materials - Modern solutions of diesel motors for railway vehicles, Mechanical transmitters for railway vehicles, Hydraulic - hydrostatic and hydrodynamic transmitters for railway vehicles, Regulation of diesel motor and transmitter joint operation, Accessories on diesel locomotives), Solving the set problem (Designing of diesel hydraulic locomotives power supply systems), Introductions with practical problems in the field of inspection and maintenance of diesel locomotives, Visiting the factory for production of diesel locomotives, Discussion and workshops.

prerequisite
Nothing

**learning resources**

Syllabus, Guidebook for solving the tasks, Handouts, Personal PC, Projector and internet access - internet exploring for additional information's.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 0
calculation tasks: 5
seminar works: 0
project design: 0
consultations: 5
discussion and workshop: 5
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 5
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 10
seminar works: 15
project design: 0
final exam: 35
requirements to take the exam (number of points): 35

**references**

Zdravko Valter, Diesel - electric locomotives, Školska knjiga, Zagreb, 1985
Manufacturing Systems Design

ID: MSc-0177
responsible/holder professor: Petrović B. Petar
teaching professor/s: Petrović B. Petar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: production engineering
semester.position: 2.1

goals

1. Understanding of modern manufacturing systems structure – a survey of main subsystems and their mutual interaction;
2. Static and dynamic properties of the manufacturing system, dynamic nature of cutting process, nonlinear phenomena of friction, chatter and other aspects affecting manufacturing system stability;
3. Fundamental knowledge of numerically controlled axes, Computer Numerical Control, control system architecture, human-machine interfacing, and manufacturing system condition monitoring;
4. Fundamental approaches to manufacturing systems design theory (Axiomatic design, TRIZ and other alternative approaches).

learning outcomes

1. The student should be able to design, i.e., conceptualize, analyze and synthesize manufacturing system in accordance to given functional requirements.
2. The student should develop knowledge, skills and practice for using broad range of CAx modeling methods, including FEM, needed for manufacturing system design and optimization.
3. The student should understand structure of Computer Numerical Control system, its basic architecture and subsystems, and how to specify and/or configure it properly.

theoretical teaching

Theoretical teaching embraces three basic teaching units:
1. Structure and configuration of the manufacturing system – generic structure of the manufacturing system; morphology, static and dynamic aspects of the machine-tool-workpiece interaction, basics of modal analysis; cutting process dynamics, and stability aspects.
2. Control system – basics of numerically controlled machine tool: servo axis, fundamental principles of servoregulation; interpolation and motion control, architecture and configuration of CNC control systems;
3. Manufacturing systems design – introduction to the theory of axiomatic design, design axioms and corollaries; functional requirements and constraints, design matrix and forms of coupling, complexity - structuring and decomposing designs, domain of technology and processes; Theory of Inventive Problem Solving (TRIZ).

practical teaching

Laboratory exercises are organized within the framework of three exercises: 1. manufacturing system statics, 2. manufacturing system dynamics and modal analysis.
techniques, and 3. control system NUMA (servo axis, engagement of servo axes and contour control, configuring a manufacturing system). Project: project of an assigned manufacturing system or any of its subsystems, focus being on multidisciplinary (mechatronics) approach in solving the problem posed. Students are oriented to using the Internet, contemporary CAD techniques in the design process, team work and practical verification in the laboratory.

**prerequisite**

Basic knowledge in Mechanics, Machine Tools, Tools, Jigs and Fixtures, Numerical methods and CAD, Electronics, Control Systems, Cybernetics.

**learning resources**

[1] P.B. Petrovich, Manufacturing systems design /In Serbian/,  
[3] Handouts in e-form /In Serbian/,  
[4] Instructions for laboratory report writing /In Serbian/,  
[5] Instructions and prominent example of the Manufacturing System Design project /In Serbian/.  
[7] Sensory and digital acquisition system for modal analysis of manufacturing systems,  
[8] Components of numerically controlled servo axes,  
[9] Open architecture CNC control system for motion control of servo driven axes in modern machine tools,  

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 6  
laboratory exercises: 6  
calculation tasks: 0  
seminar works: 0  
project design: 16  
consultations: 2  
discussion and workshop: 0  
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0  
check and assessment of lab reports: 2  
check and assessment of seminar works: 0
check and assessment of projects: 2
colloquium, with assessment: 0
test, with assessment: 6
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 25
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 15
final exam: 40
requirements to take the exam (number of points): 30

**references**

Vladimir R. Milacic, Machine Tools II, Faculty of Mechanical Engineering, Belgrade.
Missile Propulsion

ID: MSc-0689
responsible/holder professor: Elek M. Predrag
Teaching professor/s: Elek M. Predrag
Level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
Final exam: written
Parent department: weapon systems
Semester.position: 2.1

Goals

Introducing students to the fundamentals of determination of rocket engines performance parameters. Introducing students to the design of rocket engines with liquid and solid propellants, as well as special units of liquid rocket engines. Fundamentals of thrust vector control of rocket motors. Introduction to methods of rocket engines testing.

Learning outcomes

After successful completion of the course, students should be able to:
- define the performance parameters of rocket engines,
- independently calculate the main structural parts of solid propellants rocket engines,
- analyze all subsystems of liquid propellants rocket engines,
- understand different concepts of the thrust vector control systems of a rocket,
- apply the acquired knowledge in the field of experimental work on the tests of rocket engines.

Theoretical teaching

1. Performance parameters of solid propellants rocket motors (Fundamentals of combustion of solid rocket propellants; pressure equation in the solid rocket motor, pressure stability, thrust of rocket engine)
2. Performance parameters of liquid propellants rocket engines (Fundamentals of combustion of liquid propellants; characteristic length and time of residence; ignition, injectors)
3. Heat transfer in rocket engines (Fundamentals of heat transfer in rocket engines, thermal protection, cooling of liquid propellants rocket engines)
4. Design of rocket engine with solid propellants (Fundamentals of design of solid propellants rocket motors, thrust vector control, nozzle design, chamber design; design of propellant charge)
5. Design of rocket engines with liquid propellants (Fundamentals of design of liquid propellants rocket engines; chamber design; turbo-pump power systems; tank pressurization systems; thrust vector control systems)
6. Testing of rocket engines (Research, development and verification tests)

Practical teaching

1. Performance parameters of solid propellants rocket motors (Examples of calculations; introduction to the software package BALIST)
2. Performance parameters of liquid propellants rocket engines (Examples of calculations; introduction to the software package COMBUS)
3. Heat transfer in rocket motors (Calculation of thermal protection of rocket motor with solid propellants; Calculation of chamber cooling in the case of liquid propellants rocket
engine)
4. Design of rocket engines with solid propellants (Examples of design calculations)
5. Design of rocket engines with liquid propellants (Examples of the calculation of subsystems)

prerequisite

Passed exams (preferred): Fundamentals of projectile propulsion, Thermodynamics B

learning resources

1. Elek, P.: Missile propulsion - lectures, Faculty of Mechanical Engineering, Belgrade, 2012. (in Serbian)

number of hours

total number of hours: 45

active teaching (theoretical)

lectures: 18

active teaching (practical)

auditory exercises: 9
laboratory exercises: 3
calculation tasks: 3
seminar works: 3
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 3
check and assessment of projects: 0
colloquium, with assessment: 3
test, with assessment: 0
final exam: 3

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references

Jaukovic, Dj.: Fundamentals of rocket engineering; Part I: Rocket propulsion, Military Academy, 1972. (in Serbian)
Ship propulsion

ID: MSc-0956
responsible/holder professor: Simić P. Aleksandar
Teaching professor/s: Simić P. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: naval systems
semester.position: 2.1

goals

The aims of the course are to familiarize the student with various types of ship propulsors (specifics, advantages and drawbacks, selection of the best propulsor etc.). Practical training should enable the student to select/design the most adequate propulsor by applying common engineering methods, to use computer for those activities, to know how to determine necessary engine power.

learning outcomes

The student should be familiar with various types of ship propulsors and propellers in particular, their advantages and drawbacks, the concept of ship propeller design by applying common engineering methods, how to determine the needed ship engine power output.

theoretical teaching

Theoretical teaching involves familiarity with interaction between the hull and the propeller (propulsive coefficients), joint operation of the ship propeller and the engine, types of propellers and, lastly, the selection/design of propellers by using common engineering methods. Explanations are given of basic elements needed for the sea trials. The model tests and interpretation of their results are examined too.
Finally, the student is familiarized with various types of propulsors based, more or less, on the screw propeller (for example, propeller in the nozzle) as well as with those that are considerably different and are often installed in unconventional ship types or boats (for example, water‐jet propulsor). Also, transmission of power from the engine to the propulsor, which influences propulsor in great extent, is mentioned.

practical teaching

In addition to common calculation examples that follow teaching units presented theoretically, the focus is on the student’s independent design of project (which is actually a continuation of the project included in the Ship resistance course). The project, in brief, consists of performing calculations by applying common engineering methods (some with the use of the computer) to select/design the optimal propeller and then choose an adequate ship engine. Besides, the student should produce a technical drawing of the propeller.

prerequisite

Exam passed in Ship resistance.

learning resources
Lectures are available in electronic form
A detailed prominent example of the project
Internet resources

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 10
seminar works: 0
project design: 10
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 10
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 60
requirements to take the exam (number of points): 20

**references**
Steam Boiler processing

**ID:** MSc-1053  
**responsible/holder professor:** Tucaković R. Dragan  
**teaching professor/s:** Stupar M. Goran, Tucaković R. Dragan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** thermal science engineering  
**semester.position:** 2.1

**goals**

Reaching the competence and academic skills and methods for it's acquiring. Developing creative capabilities and mastering the specific practical skills. Goals determine the specific results which should be achieved within the subject. Goals also represent basis for control of the achieved results. Activities in this subject are in accordance with basic tasks and goals of the study program.

**learning outcomes**

After successfully completing the course, the students will be able to:

- Perform the thermal boiler calculation.
- Calculate the heat balance of the mill drying process and chose the type and size of the mill.
- Perform the air and flue gases aerodynamic calculations of the steam boiler and choose an appropriate fan.
- Perform the strength calculation of basic elements of a steam boiler.
- Acquire the process of corrosion and wear of heating surfaces, as well as their protection.

**theoretical teaching**

Thermal calculation of the steam boiler heating surfaces - calculation of furnace, calculation of half-radiation and convection heating surfaces; Mill processes (coal dust characteristics, heat and material balance of mill drying process, mill control diagram); Aerodynamic of the air and flue gas tract (balanced draft boiler, forced draft boiler and natural draft boiler); Hydrodynamics of steam boiler (hydrodynamics of water heater, evaporator and superheater); Steam boiler strength calculation; Corrosion, wear, defilement and cleaning of steam boiler elements.

**practical teaching**

Auditory exercises consist of demonstration exercises (Classification and construction of steam boilers with appropriate heating surfaces, auxiliary devices and equipment); Guidelines for preparation of the project - Based on information (obtained and calculated) in the project from subject Steam boiler elements and equipment, it is necessary to develop thermal calculations for given industrial steam boiler. In this project it is necessary to perform thermal calculation and dimensioning of the following heating surface - furnace (radiation evaporator), convective evaporator, steam superheaters, water and air heaters. After dimensioning the steam boiler heating surfaces, it's necessary to make the steam boiler drawing in three sections.

**prerequisite**
Necessary condition: Bachelor's degree;  
Preferred passed exam: Steam boilers elements and equipments

**learning resources**

Books: Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers, Faculty of Mechanical Engineering, Belgrade, 2010, (In Serbian); Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers Thermal Calculation, Faculty of Mechanical Engineering, Belgrade, 2010, (In Serbian); handouts which will be at student's disposal a week in advance

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 6  
laboratory exercises: 0  
calculation tasks: 0  
seminar works: 0  
project design: 14  
consultations: 0  
discussion and workshop: 10  
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0  
check and assessment of lab reports: 0  
check and assessment of seminar works: 0  
check and assessment of projects: 4  
colloquium, with assessment: 6  
test, with assessment: 0  
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0  
test/colloquium: 30  
laboratory exercises: 0  
calculation tasks: 0  
seminar works: 0  
project design: 30  
final exam: 40  
requirements to take the exam (number of points): 30

**references**
Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers, Faculty of Mechanical Engineering, Belgrade, (In Serbian)
Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers Thermal Calculation, Faculty of Mechanical Engineering, Belgrade, (In Serbian)
Steam Turbines 2

ID: MSc-0174  
responsible/holder professor: Petrović V. Milan  
teaching professor/s: Petrović V. Milan  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written+oral  
parent department: thermal power engineering  
semester.position: 2.1

goals

1. The achievement of academic competence in the field of steam turbines and thermal power engineering.
2. The achievement of theoretical knowledge about how to transform heat into mechanical work learning thermodynamic processes and equipment (steam turbine and steam turbine power plants).
3. The acquisition of practical knowledge to optimize thermodynamic cycle and steam turbines.
4. The achievement of the techniques of process modeling.
5. Mastering the methods of experimental work in thermal power engineering.

learning outcomes

On completion of this programme, it is expected that student will be able to:
• optimization calculation of the turbine stage and select dimensionless stage parameters;
• selects the type of turbine cascade, construct airfoils and calculated the corresponding losses,
• set up a concept of the turbine relating to number of cylinars and the number of flow
• determine number of the turbine stages,
• conduct a detailed calculation of a turbine stages determining the main dimensions of the steam turbine,
• apply the theory of 3D flow for the turbine stages,
• perform basic design of steam turbine based on the carried calculations,
• knows the problems of operation and design of the last steam turbine stage,
• analysis of the problems of strength of the various elements of steam turbines
• analyze the main problems vibration structural elements of the steam turbine,
• select the methods of regulating and analyze the operation of steam turbine at off design conditions.

Theoretical teaching

Theoretical teaching is carried out through 10 teaching modules:
1) 3D flow in steam turbines stages.  
2) 3D flow in stages with large length blades.  
3) Design of steam turbines.  
4) Multistage steam turbines.  
5) Blades - design, stress, constant strain blades, vibration and erosion.  
6) Steam turbine rotors - construction, stress, vibration.  
7) Housing of steam turbines - design, stress, deformation and thermal dilation.
Commissioning of steam turbines in operation, heating, cooling.
8) Steam turbine bearings - design, lubrication. Labyrinth seals. Protection components of steam turbines.
9) Operating characteristics of steam turbines, consumption cone.
10) Regulation of steam turbines, thermodynamic and functional problems.

**practical teaching**

Practical training is carried out through:
Auditory exercises:
Instructions for the project. Calculation and construction of steam turbines. Selection of blade profiles. Design turbine of high, medium and low pressure. Calculation of the number of stages. Calculation of the turbine last stage.
Labs:
Measurement of vibration of the rotor and the frequency of free oscillations of the steam turbine blades in the Laboratory of Mechanical Engineering.
Project development:
Calculation and design of steam turbines
Excursion:
Visit one thermal power plant in Serbia

**prerequisite**

Passed exams in Thermodynamics and Fluid mechanics

**learning resources**

Vasiljevic, N.: Steam turbines Faculty of Mechanical engineering, Belgarde, 1987.
Petrovic, M.: Instruction for steam turbine projet, Belgrade, 2004
Petrovic, M.: Scripts and handouts for Steam turbines
Instructions for performing laboratory exercises
Software package for calculating of properties of steam and water.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 14
laboratory exercises: 4
calculation tasks: 0
seminar works: 0
project design: 12
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**
check and assessment of calculation tasks: 0
check and assessment of lab reports: 1
check and assessment of seminar works: 0
check and assessment of projects: 7
colloquium, with assessment: 2
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 10
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 50
requirements to take the exam (number of points): 25

**references**

Stojanovic, Themal Turbomachinary, Gradjevinska knjiga, belgrade, 1967.
Structural and Stress Analysis

ID: MSc-0910
responsible/holder professor: Gašić M. Vlada

level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written

parent department: material handling, constructions and logistics
semester.position: 2.1

goals

Basic goal of this course is introduction to principles in design and calculation of steel structures for a wide range of material handling machines (mining machines, earthmoving machines, cableways and lifts). Also, goal is development of student creative skills for designing the light but safe structures, i.e. rational structures.

learning outcomes

After the completion of the course, student is trained to:
• Calculate the shear stresses of the thin-walled closed section, such as on box girder of bridge crane
• Calculate first moments of area of thin-walled open section
• Obtain the position of the shear centre of the thin-walled open section and form the warping coordinate
• Analyze the warping torsion effects for beams and cantilevers with thin-walled open section, determine the warping loads and calculate the stresses due to bimoment and warping torsion
• Perform the complete stress proof of girders made of thin-walled open section

theoretical teaching


practical teaching

Calculation of section properties for thin-walled open section beams: centre of gravity, first moment of area, second moment of area, torsional constant, warping constant. Determination of shear centre for various thin-walled open sections. Calculation of shear stress distribution and bending stress distribution at characteristic sections performed on several types of thin-walled open section simple beams and cantilevers under loads. Determination of shear centre for thin-walled sections with developed software package.

prerequisite

Necessary: Mathematics 1, Mathematics 2, Strength of materials.
Advisable: Fundamentals of steel structures

learning resources
number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 20
laboratory exercises: 5
calculation tasks: 5
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 4
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 0
calculation tasks: 20
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references

Zoran Petkovic: Metalne konstrukcije u masinogradnji 2, Faculty of Mechanical Engineering, Belgrade, 2005.
Vlada Gašić: Osnove metalnih konstrukcija u mašinogradnji, Handbook, Faculty of Mechanical Engineering, Belgrade, 2017
Theory of elasticity

**ID:** MSc-0903  
**responsible/holder professor:** Milošević-Mitić O. Vesna  
**teaching professor/s:** Andelić M. Nina, Milošević-Mitić O. Vesna  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** strength of structures  
**semester.position:** 2.1

**goals**

The purpose of this course is that students understand and learn the basic concepts of the theory of elasticity. They will acquire the basis of the tensor method, too. Students will enable to model and solve some reological problems. Through understanding the reological processes they will be able to use computer programs in this field.

**learning outcomes**

- By negotiation of this program, students will master some basic methods and procedures of the theory of elasticity and of the tensor method.  
- They will be able to calculate stress components on the base of balance equations and to form appropriate tensors of stress and strain for an ideal elastic body.  
- They will be introduced with principal stresses (intensity, position) and with maximum shear stress.  
- They will be able to calculate main strains.  
- Students will master application of hypothesis about the collapse of material.  
- They will understand elasticity and stiffness matrixes.  
- They will be able to solve some real problems related to thin simply supported plates.

**theoretical teaching**


**practical teaching**

prerequisite

Set by the Curriculum of the study program

learning resources

Handouts from the website of the Department for Strength of the constructions

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 20
laboratory exercises: 0
calculation tasks: 5
seminar works: 5
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 3
check and assessment of lab reports: 0
check and assessment of seminar works: 3
check and assessment of projects: 0
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 0
final exam: 40
requirements to take the exam (number of points): 20

references
Theory of elasticity, T. Atanacković
Theory of elasticity, S. Tymoshenko, J. N. Gudier
Sets of the structural strength, T. Maneski, V. Milosevic-Mitic, D. Ostric
Vehicle Propulsion and Suspension Systems

**ID:** MSc-1142  
**responsible/holder professor:** Rakićević B. Branislav  
**teaching professor/s:** Blagojević A. Ivan, Mitić R. Saša, Rakićević B. Branislav  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** motor vehicles  
**semester.position:** 2.1

**goals**

Mastering the knowledge and skills necessary to perceive and understand the problems related to the design and calculation of vehicle transmission, suspension system and steering system and their impact on the characteristics and behavior of the vehicle.

**learning outcomes**

Upon successful completion of this course, students should be able to: Explain the process of calculation of transmission, suspension system and steering system; Perform calculation of transmission, suspension system and steering system; Analyze the possibilities of predicting the impact of newly designed solutions of propulsion and suspension systems on the performance of the vehicle.

**theoretical teaching**

Theoretical classes consist of the following units: Design and calculation of transmission systems; Design and calculation of hydrodynamic and hydrostatic transmissions; Functional-constructive characteristics of suspension system and wheels; Characteristic performances and their specificities; The influence of suspension system and wheels on the longitudinal, lateral and vertical dynamics of the vehicle; Kinematic-geometric characteristics of suspension system and its influence on the distribution of the relevant forces and vehicle behavior.

**practical teaching**

Practical classes consist of individual project and additional assignments.

**prerequisite**

No special requirements.

**learning resources**

N. Janićijević, D. Janković, J. Todorović: Motor Vehicle Design (in Serbian), University of Belgrade, Faculty of Mechanical Engineering.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**
lectures: 30

**active teaching (practical)**

auditory exercises: 15  
laboratory exercises: 0  
calculation tasks: 0  
seminar works: 0  
project design: 15  
consultations: 0  
discussion and workshop: 0  
research: 0  

**knowledge checks**

check and assessment of calculation tasks: 0  
check and assessment of lab reports: 0  
check and assessment of seminar works: 0  
check and assessment of projects: 5  
colloquium, with assessment: 5  
test, with assessment: 0  
final exam: 5  

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10  
test/colloquium: 30  
laboratory exercises: 0  
calculation tasks: 0  
seminar works: 0  
project design: 30  
final exam: 30  

requirements to take the exam (number of points): 35  

**references**

N. Janićijević, D. Janković, J. Todorović: Motor Vehicle Design (in Serbian), University of Belgrade, Faculty of Mechanical Engineering.  
B. Rakićević, I. Blagojević, S. Mitić - Vehicle Propulsion and Suspension Systems lecture handouts  
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Welding metallurgy

**ID:** MSc-0901  
**responsible/holder professor:** Prokić-Cvetković M. Radica  
**teaching professor/s:** Popović D. Olivera, Prokić-Cvetković M. Radica  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written + oral  
**parent department:** engineering materials and welding, tribology, fuels and combustion  
**semester.position:** 2.1

**goals**

The aim of this course is for students to become competent in the areas of materials and welding and also to develop appropriate academic skills needed for the future profession. This course is designed to provide informations through theoretical lectures, computational classes, seminar papers and through welding workshop practice.

**learning outcomes**

Upon the successful completion of the course, the students are able to:
- Understand the distribution of temperature in the material during welding, and the influence of heat input on metal solidification
- Name all possible types of cracking (hot-, cold-, lamellar-, and reheat cracking) that may appear in the welding process, and to be able to differentiate between them
- Understand the metallurgical aspects of various steel classes (carbon-, low alloyed, high alloyed, stainless), and select the proper welding technique and appropriate welding consumables
- Understand the metallurgical aspects of weldability of different types of non-ferrous metals and alloys (Al and Al alloys; Cu and Cu alloys; Ni and Ni alloys; Ti, Zr, Mg and their alloys)
- Understand the metallurgical aspects of the weldability of heterogeneous metals
- Apply the concept of predicting crack appearance in the welded joint depending on the type of material and welding technology, in the goal to avoid the occurrence of damage and failure

**theoretical teaching**


**practical teaching**

prerequisite


learning resources


number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 12
laboratory exercises: 6
calculation tasks: 1
seminar works: 15
project design: 0
consultations: 6
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 2
check and assessment of projects: 0
colloquium, with assessment: 2
test, with assessment: 6
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 50
laboratory exercises: 5
calculation tasks: 0
seminar works: 10
project design: 0
final exam: 30
requirements to take the exam (number of points): 20

references
B. Sabo at all, Weldability stainless steels, N. Sad, 1995.
Automatic Weapons

ID: MSc-0181
responsible/holder professor: Micković M. Dejan
teaching professor/s: Micković M. Dejan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 2
final exam: written
parent department: weapon systems
semester.position: 2.2

goals

Introducing of students to the basic elements of the automatic weapons. Formation of the system of differential equations that describe the movement of elements of the mechanisms of automatic weapons during the firing cycle. The study of methods for solving these differential equations. Preliminary design of various systems of automatic weapons.

learning outcomes

Mastering the calculation of basic parameters that characterize the function of various systems of automatic weapons. Acquiring the ability of students to create their own software tool for preliminary design of an automatic weapon. Qualifications for the design of individual elements of the automatic systems and optimisation of function of different types of automatic weapons.

theoretical teaching


practical teaching

stroke pistons, short stroke pistons, direct gas action).

**prerequisite**

Desirable - passed the exam in the subject Classical Armament Design.

**learning resources**


**number of hours**

total number of hours: 30

**active teaching (theoretical)**

lectures: 12

**active teaching (practical)**

auditory exercises: 7
laboratory exercises: 0
calculation tasks: 0
seminar works: 2
project design: 0
consultations: 3
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 1
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

**references**
Pamphlet 706-260, 1970
Automotive friction systems

ID: MSc-0872
responsible/holder professor: Aleksendrić S. Dragan
teaching professor/s: Aleksendrić S. Dragan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: motor vehicles
semester.position: 2.2

goals

Course objective is to provide an understanding and develop students’ skills and knowledge in the area of design, development, and maintenance process of the friction based vehicle systems such as clutch, braking systems, and friction materials.

learning outcomes

Course outcomes are development of student’s abilities to: a) understand requirements being imposed to automotive vehicle systems, b) be able to design, calculate and testing of the motor vehicles braking systems, c) be able to design, calculate and testing of the vehicle main clutches, d) be able to understand and design the automotive brakes and clutches friction material characteristics, e) be able to maintain the friction based vehicle systems.

theoretical teaching

Theoretical lectures are divided into 7 sections:
1) Introduction – Friction based vehicle systems.
2) Clutch – design, calculation and testing.
3) Braking systems- Introduction
4) Characteristics of vehicle braking systems
5) Design and calculation of vehicle braking systems
6) Characteristics of clutch and brake friction materials.
7) Maintenance of clutch and braking systems- Introduction.

practical teaching

Students carry an engineering project. Project is related to the following tasks:
1) Calculation of the main friction clutch.
2) Calculation of a passenger car braking system.
3) Calculation of a braking system with the pneumatic transmission.
4) Calculation of a braking system with the air over hydraulic transmission.
5) Calculation of trailer/semi-trailer braking system.

prerequisite

There is no precondition.

learning resources


**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 0
calculation tasks: 15
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 5
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 0
calculation tasks: 20
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**

Biomechanics of tissue and organs

ID: MSc-0559
**responsible/holder professor:** Lazarević P. Mihailo
**teaching professor/s:** Lazarević P. Mihailo
**level of studies:** M.Sc. (graduate) academic studies
**ECTS credits:** 4
**final exam:** oral
**parent department:** mechanics
**semester.position:** 2.2

**goals**

To introduce students to the application of fundamental principles and laws of biomechanics of tissues and organs in order to understand and study them. Establishment of an appropriate biomechanical model of tissue and organs using modern theory of viscoelasticity, the possibility of simulations based on them in order to confirm the experimental data, the possibility of applying for the purposes of design and design basis of the same. It allows the potential cooperation with experts in medicine or work in specialized clinical institutions.

**learning outcomes**

- Applying basic principles and laws linear theory of elasticity (LTE), the basics of continuum mechanics to understand and study the biomechanical properties and characteristics of human tissues and organs (HTO)
- Identify the most important rheological properties of considered HTO
- Distinguish between (Kelvin-Voigt, Maxwell model, Standard linear solid (SLS) model) on the basis of the linear theory of viscoelasticity (LTV)
- Forming the appropriate rheological models HTO applying LTE in time and frequency domain
- Numerical simulate the previously formed rheological models using programming environment (MATLAB, etc.).
- Identify the properties and characteristics of non-linear and plastic behavior considered HTO

**theoretical teaching**


Injury of the organ / tissue - the biomechanical modeling them. Biomechanical engineering to prevent tissue trauma. Biomechanical aspects of the growth of tissues / organs. Engineering tissues and organs. History and perspectives of future development of artificial tissue/organ
practical teaching

Introductory examples of tensor analysis. Biomechanical properties of hard tissues such as tooth-and bone man. Biomechanical properties of soft connective tissues—such as muscle, the muscle fibers. Biological-tissue modeling using LTE. Examples: elastin, collagen, cartilage-props. Modeling the behavior of biological tissue using LTVE: for example lung tissue, blood vessels. Biomechanical models of the respiratory, nervous and lymphatic systems. Structure and function of pulmonary parenhina. Examples of dynamic behavior of biological tissues / organs: the stress relaxation, creep, hysteresis. The case of the dynamic behavior of the diaphragm. An illustrative example of the final elastic deformation. Examples povrde organs / tissues: head and spinal cord-biomechanical models of the same. Tolerance of organs / tissues to impact operećenja. The growth of tissues and organs - such as bones. Examples of artificial models of tissues /organs (body parts).

prerequisite

desirable courses: Fundamentals of biomedical engineering, Human anatomy and physiology, Biomechanics of the human locomotor system

learning resources

[3] М. Лазаревић, Биомеханика ткива и органа (скрипта у припреми), 2013
[7] WWW internet laboratorije, MATLAB,

number of hours

total number of hours: 45

active teaching (theoretical)

lectures: 18

active teaching (practical)

auditory exercises: 6
laboratory exercises: 3
calculation tasks: 4
seminar works: 0
project design: 2
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 2
check and assessment of lab reports: 0
check and assessment of seminar works: 1
check and assessment of projects: 1
colloquium, with assessment: 2
test, with assessment: 1
final exam: 3

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 45
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 15
final exam: 30
requirements to take the exam (number of points): 35

references

H. A. Barnes, J. E. Hutton, K. Walters F. R. S, An Introduction to rheology, Elsevier Amsterdam, 1993
Biotechnology

**ID:** MSc-0992  
**responsible/holder professor:** Jovović M. Aleksandar  
**teaching professor/s:** Jovović M. Aleksandar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** process and environmental protection engineering  
**semester.position:** 2.2

**goals**

The purpose of subject is for students to get knowledge about basic processes and equipment, which is used in biotechnology. Through the semester students’ projects, students get creative and specific practical skills for construction of process equipment. The laboratory exercises have the aim to give appropriate knowledge to students about examination of process equipment during the production as well as the exploitation process.

**learning outcomes**

After successful course attending students get ability for: analysis, synthesis and predicting solutions and consequences; developing of critic and self critic thinking and approach; practical knowledge implementation; professional ethic; connecting knowledge from different subjects and their implementation; developing skills and abilities for knowledge implementation in adequate area.

**theoretical teaching**


**practical teaching**


**prerequisite**

Elective course. There is no specific requirement for course attending.

**learning resources**

Faculty of Mechanical engineering — course catalog — M.Sc. (graduate) academic studies
2. Laboratory facility for determination of aerator characteristics in bubble aeration bioreactors, Laboratory of process technique (room 6), LPI

**Number of hours**

total number of hours: 75

**Active teaching (theoretical)**

lectures: 30

**Active teaching (practical)**

auditory exercises: 19
laboratory exercises: 2
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 9
discussion and workshop: 0
research: 0

**Knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 4
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 6
final exam: 5

**Assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 45
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30

requirements to take the exam (number of points): 30

**References**
Bogner, M. at all.: Handbook of thermal technique, Interklima grafika, Vrnjačka Banja, 2003
Buoyancy and Stability of Ship 2

ID: MSc-0695
responsible/holder professor: Bačkalov A. Igor
teaching professor/s: Bačkalov A. Igor
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: naval systems
semester.position: 2.2

goals

To cover the advanced knowledge of Naval Architecture connected to ship buoyancy and stability: ship loading, flooding, damaged ship stability and grounding. It is a continuation of the course Buoyancy and Stability of Ship 1.

learning outcomes

Ability to solve and analyze practical engineering tasks connected to ship loading/unloading, damaged ship stability and grounding. Practical knowledge of ship flooding calculations, according to international regulations.

theoretical teaching

Loading/unloading of cargo: centric loading (small and large cargo, liquid cargo), eccentric loading. Flooding: alternative methods (added weight or lost buoyancy), centric and eccentric flooding, flooding of compartments with solid and liquid cargo. Damaged ship calculations: deterministic and probabilistic calculations, curve of floodable length, regulations. Ship grounding: bottom reaction (small and large), grounded ship stability, critical reaction, docking. Methods for improving ship stability.

practical teaching

Practical problems of ship buoyancy and stability, illustrating the subjects lectured in the theoretical syllabus. In addition, students have to accomplish individually the project: Flooding calculations (done in accordance to SOLAS regulations) for the ship already analyzed in projects of Buoyancy and Stability of Ship 1 (ship lines drawing, hydrostatic curves and intact stability calculations).

prerequisite

Semester 8 enrolled. Exam passed in Buoyancy and Stability of Ship 1.

learning resources

[1] Hofman, M.,: Extracts from lectures (handouts) /In Serbian/

number of hours

total number of hours: 75
active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 15
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 25
final exam: 50
requirements to take the exam (number of points): 34

references

Biran, A., Ship Hydrostatics and Stability, Butterworth Heinemann 2003
Computer Integrated Manufacturing Systems and Technology

**ID:** MSc-0665  
**responsible/holder professor:** Babić R. Bojan  
**teaching professor/s:** Babić R. Bojan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** production engineering  
**semester.position:** 2.2

**goals**

A detailed study of the principles and application of computer integrated manufacturing. Advanced concepts and models related to computer-aided design, computer-aided process planning, computer aided manufacturing, production planning and scheduling.

**learning outcomes**

This course will enable the student to:
- apply knowledge of modeling, simulation and visualization in industrial applications,
- design CIM systems that satisfy the given conditions,
- identify and solve problems in the operation of the CIM system,
- improve the performance of manufacturing systems using different CIM concepts and tools,
- handle production data and the different software used in production.

**theoretical teaching**

1. Introduction to CIM  
2. Computer-aided Design  
3. Automated Manufacturing Equipment  
5. Shop Floor Control and Introduction of FMS  
6. Production Planning and Control  
7. Cim Implementation and Data Communication

**practical teaching**

Laboratory work includes computer-aided applications and programming of automated production equipment.

**prerequisite**

Defined by curriculum of study programme/module.

**learning resources**

1. B. Babic, Computer integrated systems and technologies, University of Belgrade, Faculty of Mechanical Engineering, 2017  
2. B. Babic, Software "Moodle" for distance learning (http://147.91.26.15/moodle/), University of Belgrade, Faculty of Mechanical Engineering, 2012  
3. AnyLogic simulation software  
4. B. Babic, Software packages for process planning
number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 8
calculation tasks: 3
seminar works: 0
project design: 15
consultations: 4
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 4
colloquium, with assessment: 2
test, with assessment: 4
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 15
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 35
final exam: 30
requirements to take the exam (number of points): 30

references

B. Babic, Computer integrated systems and technologies, University of Belgrade, Faculty of Mechanical Engineering, 2017
Design and Construction M

ID: MSc-0373
responsible/holder professor: Mitrović M. Radivoje

level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6

goals

Acquisition of basic knowledge of designing and constructing machinery elements and structures. Mastering the methods of construction and design process. Developing skills of teamwork and interconnecting knowledge and skills in various fields of Mechanical Engineering. Training for further study.

learning outcomes

After attended course, students gain knowledge about:
• Through the design stages they will be able to selects the optimum variant design from technological and economic point of view - Techno-economic analysis,
• Applying technical directives and regulations in the machine design and putting the product on the market,
• Evaluate the operational capacity of pressed joints,
• Resolves advanced problems with measuring chains
• Check capacity of thin and thick-walled pressure vessels from strength point of view,
• Make a selection of welded joints in terms of mutual position of the parts to be joined,
• To form and do the technical documentation of given mechanical construction.

theoretical teaching


practical teaching


prerequisite

Passed all fundamental exams on B.Sc studies.

learning resources

Laboratory of Machine design, University of Balgrade, Faculty of Mechanical Engineering. Handouts, Presentations, Wireless Internet connection and access to the course Web presentation provided with usefull links.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 4
project design: 0
consultations: 6
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 2
check and assessment of projects: 0
colloquium, with assessment: 4
test, with assessment: 4
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 25
laboratory exercises: 0
calculation tasks: 30
seminar works: 10
project design: 0
final exam: 30
requirements to take the exam (number of points): 35
references

Ognjanović M.: Machine design, Faculty of Mechanical Engineering, Belgrade, 2000., in Serbian
S.Veriga: Machine elements 1, Faculty of Mechanical Engineering, Belgrade, 2000., in Serbian
FME, in sebian
Engineering Design Methods

ID: MSc-1095
responsible/holder professor: Rosić B. Božidar

Teaching professor/s: Ognjanović B. Milosav

Level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

Final exam: written

Parent department: general machine design

Semester position: 2.2

Goals

Introducing of the wide range of methods used in engineering design, i.e. creation of technical systems. Some of the methods were the content of study in subjects who have preceded it, is seen in their place and role in the development of TS. The main goal is to introduce new specific methods and procedures for their application. It is a contemporary and current methods that lead to a high degree of quality and to desired behaviors of TS while satisfying the required functions and achieve a high degree of compliance with the environment in the ecological, aesthetic, economic, and other necessary aspects.

Learning outcomes

After successful completion of this course, students should be able to do the next.

- To apply previously acquired and new knowledge in engineering design.
- To use the methods oriented development of selected properties of TS (DFX) methods.
- To transform the achieved level of knowledge in TS calculation and analysis.
- To apply methods and techniques of searching for ideas and solutions in the development of TS.
- To apply methods based on the properties - decomposing and integrating the structure and properties of TS in order to reach the desired behavior in relation to the environment and the achieved level of scientific and technological knowledge.
- Using experimental and empirical approaches and methods to supplement the missing knowledge and data in innovative development TS.

Theoretical teaching


Practical teaching

In the course of semester the students working out the project which that allows them to understand the process and to develop the skills for transformation of conceptual design into embodiment design. The starting point is existing conceptual design and by corresponding methods application students create innovative design solution. Auditory exercises also contains analysis and discussions of issues and practical examples covered by theoretical classes with the aim to introduce students to the phenomena that need to process in their project work and to prepare for the tests.
prerequisite

Lecture and exercise finished of the subject “Innovative design of technical systems”

learning resources

2 Examples with the solutions and the necessary data for the calculations are given in the book referred to in the point 1.
3 Power-Point presentations, lectures available to students in the form of hand-out materials.
4 Laboratory for Design in Mechanical Engineering.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 0
discussion and workshop: 10
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 4
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 30
requirements to take the exam (number of points): 35
references

Orloff M.A.: Innovative Thinking through TRIZ - A practical guide, Springer - Verlag
**Ergonomic designing**

**ID:** MSc-0417  
**responsible/holder professor:** Žunjić G. Aleksandar  
**teaching professor/s:** Žunjić G. Aleksandar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** industrial engineering  
**semester.position:** 2.2

**goals**

The aim of this course is the acquisition of basic academic knowledge in the field of ergonomic designing, which can be used for designing of different products, as well as for redesigning and improvement of system man - machine - environment. Students should acquire specific practical skills that include an integrated ergonomic approach for the purpose of a comprehensive settlement of various designing problems.

**learning outcomes**

Upon successful completion of this course, students should be able to:

- Apply ergonomic approach to all stages of the design process, during the design of simple or complex systems
- To apply various ergonomic tools for the purpose of realization of a project
- Design the indicators based on the application of ergonomic recommendations and carry out the assessment of the adequacy of indicators based on the application of the experimental procedure
- Design the controls based on the application of ergonomic recommendations
- Apply the ergonomic principles and recommendations on designing workplaces
- Apply the ergonomic principles and recommendations on the design of the working environment and to conduct an assessment of the working conditions based on the application of experimental procedures
- Recognize the benefits and learn about the possibilities of applying software intended for computer-aided ergonomic design
- Apply the anthropometry in designing various products and transportation systems
- Perform ergonomic assessment of an interface
- Understand and recognize the ergonomic characteristics of the quality of products
- Identify the factors that affect the comfort and safety of a vehicle from the ergonomic aspect
- Carry out the selection of the appropriate ergonomic method for design or evaluation of a system

**theoretical teaching**

practical teaching

Writing of a seminar paper - each student selects one of a number of topics, for which he is writing seminar paper in the form of professional work. The first laboratory exercise: Assessment of conditions of working environment - the criteria for assessing of conditions of working environment are presented and carries out the assessment of the conditions of a working environment at the selected workplace. The project task - Application of anthropometry in designing. The second laboratory exercise: Readability of analogue visual displays - the criteria for the assessment of readability are presented and testing of analogue visual displays is performed in the laboratory conditions.

prerequisite

The necessary condition for attending the course is that the student have enrolled to the appropriate semester.

learning resources

Žunjić A. and Ćulić M., 2007, Practicum for laboratory exercises in industrial ergonomics, Faculty of Mechanical engineering, Belgrade - available in the bookstore and library of the Faculty of Mechanical Engineering. Klarin M. and Žunjić A., 2007, Industrial ergonomics, textbook, Faculty of Mechanical engineering, Belgrade - available in the bookstore and library of the Faculty of Mechanical Engineering. Tachistoscope, sound level meter, konimeter, psychrometer, lux meter, anthropometric measuring equipment, available in the lab. 417.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 11
calculation tasks: 0
seminar works: 8
project design: 6
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 5
check and assessment of seminar works: 3
check and assessment of projects: 3
colloquium, with assessment: 0
test, with assessment: 0
final exam: 4
assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 20
calculation tasks: 0
seminar works: 20
project design: 10
final exam: 40
requirements to take the exam (number of points): 40

references

Žunjić A. and Ćulić M., 2007, Practicum for laboratory exercises in industrial ergonomics, Faculty of Mechanical engineering, Belgrade.
Klarin M. and Žunjić A., 2007, Industrial ergonomics, textbook, Faculty of Mechanical engineering, Belgrade.
Flight Dynamics

**ID:** MSc-0949  
**responsible/holder professor:** Mitrović B. Časlav  
**teaching professor/s:** Bengin Č. Aleksandar, Kostić A. Ivan, Mitrović B. Časlav, Peković M. Ognjen  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** aerospace engineering  
**semester.position:** 2.2

**goals**

The main objective of the course is to develop understanding of the stability and controllability of the aircraft. This course directly prepares student to apply knowledge of the stability, maneuverability and aircraft control in the design of the aircraft. Within the project assignment that encompasses and integrates the whole curriculum, the students will be able to fully master the analysis of stability and maneuverability in the design of aircraft by using modern software packages.

**learning outcomes**

Having mastered the planned curriculum, the student acquires sufficient theoretical knowledge to be able to independently define the state of the static and dynamic stability and maneuverability of modern aircraft and any flight restrictions that arise from it. In this course, students will receive full sublimation and the verification of previously acquired knowledge and skills that they have required within the aviation modules from the group of aerodynamic subjects.

**theoretical teaching**

- Introduction.  
- Revision of mechanics of aircraft flight.  
- Basic concepts of stability and controllability of the aircraft.  
- Differential equations of stability.  
- Stability criteria.  
- Aerodynamic stability derivatives.  
- Static stability and controllability of the airplane.  
- Dynamic stability and controllability of the aircraft.  
- Aircraft parts contributions to the longitudinal stability (wings, horizontal tail, fuselage and nacelle contributions).  
- Power plant influence on the longitudinal static stability.  
- Neutral point of the aircraft.  
- Angle of horizontal stabilizer setting.  
- Balancing with the deflection of elevator.  
- Marginal rear and front position of the aircraft centre of gravity permitted.  
- Longitudinal static stability of the aircraft.  
- Static stability of the aircraft in maneuvering flight.  
- Lateral static stability and maneuverability of the aircraft – Dihedral effect.  
- Dynamic stability of the aircraft.  
- Longitudinal dynamic stability.
- Lateral-directional dynamic stability.

**practical teaching**

Criteria of stability and controllability of the aircraft movement. Calculation of the certain aircraft parts contribution to the total longitudinal stability with the control held. Rear position of the centre of the aircraft gravity. Calculation of the longitudinal controllability of the aircraft. Calculation of the longitudinal static stability with the control released. Calculation of forces acting on the stick in steady flight. Calculation of the longitudinal static stability in maneuvering flight with the control held. Calculation of the longitudinal static stability in maneuvering flight with the control released. Derivatives and parameters in the equations of the aircraft motion. Experimental determination of stability derivatives. Computation tasks from the contents taught in the course. Tutorials follow the theoretical lectures. Consultations.

**prerequisite**

No special conditions

**learning resources**

Basic material: Ć. Mitrović – Flight Dynamics (handouts) and instructions for project assignment (handouts). Necessary material for lectures, tutorials, assignments, projects and term papers will be available to the students on the following website http://vaz.mas.bg.ac.rs/moodle.

**number of hours**

Total number of hours: 75

**active teaching (theoretical)**

Lectures: 30

**active teaching (practical)**

Auditory exercises: 5
Laboratory exercises: 10
Calculation tasks: 5
Seminar works: 0
Project design: 0
Consultations: 10
Discussion and workshop: 0
Research: 0

**knowledge checks**

Check and assessment of calculation tasks: 0
Check and assessment of lab reports: 5
Check and assessment of seminar works: 0
Check and assessment of projects: 5
Colloquium, with assessment: 0
Test, with assessment: 0
Final exam: 5
assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 10
calculation tasks: 10
seminar works: 0
project design: 40
final exam: 30
requirements to take the exam (number of points): 35

references

C. Mitrovic - Flight Dynamics (handouts) and instructions for the preparation of Terms of Reference (handouts)
Fluid Mechanics 1

ID: MSc-0829  
responsible/holder professor: Stevanović D. Nevena  
teaching professor/s: Milićev S. Snežana, Stevanović D. Nevena  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written+oral  
parent department: fluid mechanics  
semester.position: 2.2

goals

Aims of the course is to introduce students to basic principles and laws in fluid mechanics. Deeper understanding of basic equations of fluid mechanics allows the student to successfully apply them in process of finding the solution to specific engineering problems, and also improves his scientific and practical development.

learning outcomes

Students are trained to:
- apply the basic equations of fluid mechanics ie. equations of continuity, momentum and energy to describe the one-dimensional compressible fluid flow, two-dimensional potential incompressible fluid flow and fluid flow in the boundary layer;
- calculate one-dimensional subsonic and supersonic compressible fluid flow, such as: isentropic flow, adiabatic and isothermal flow with friction, inviscid gas flow with heat transfer, shock wave as well as the gas flow through the convergent and Laval nozzle;
- determine the velocity and pressure field for potential incompressible fluid flow which enables them to calculate forces which act on the contour in inviscid fluid stream. Also, based on acquired knowledge, by applying complex potentials, they can form complex flows which enable obtaining the desired contour shape and force which act on it;
- solve the boundary layer equations for flow over a flat plate and calculate friction shear stress at the plate surface, and therefore the drag force.
- modeling the turbulent flow by using the theory of turbulent flow and turbulent stresses models.

theoretical teaching


Application of momentum equation: turbo-reactive jet engine, Euler’s equation for turbo-machines, Pelton turbines.

Boundary layer theory. Prandtl theory. Boundary layer over a flat plate. Application of integral methods to boundary layer calculation.


**practical teaching**


One-dimensional inviscid and viscous compressible flow through pipes and jets. Adiabatic and isothermal compressible flow with friction. Shock waves.


Prandtl equations of boundary layer. Integral methods application to boundary layer calculation.

**prerequisite**

Passed exams in following subjects: Fluid Mechanics B.

**learning resources**

Books of professors from the department, laboratory equipment; printed and hand-witten materials (handouts).

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 28
laboratory exercises: 2
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 3
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 45
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 20

references

Чантрак С., Хидродинамика, Машинас факултет
IC Engines Mechatronics

**ID:** MSc-0855  
**responsible/holder professor:** Miljić L. Nenad  
**teaching professor/s:** Miljić L. Nenad  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** internal combustion engines  
**semester.position:** 2.2

**goals**

The aim of the course is to provide comprehensive insight into the specific subject matter of mechatronics systems used in IC Engines. To gain experience on functioning and using sensors and actuators specific for state of the art IC engines. To get closer acquaintance with the structure and architecture of the IC engine electronic control units (ECU), microcontrollers functions, in general, and methods of ECU software developing and testing.

**learning outcomes**

Ability to integrate specific electronic and mechanical engineering knowledge, with sound understanding of IC Engine mechatronic systems; More complete knowledge of IC Engine control; Ability to form IC Engine specific mechatronic system; Basic competence in ICE ECU programming and software testing; Knowledge in automotive bus communication, especially in ICE ECU data exchange.

**theoretical teaching**

Introduction to the mechatronics in IC Engines; Sensors and their characteristics; Measurement chains; Sensor calibration; "Intelligent" sensors; Sensing air/fuel ratio and exhaust gasses; Lubrication Oil monitoring sensor; Sensors of rotational and linear position and speed; Mass air flow sensors; IC Engine temperature and pressure sensors; Knock sensors; Actuators - classification; Power actuators (high voltage/current) and basics of power electronics; Ignition and Fuel injection system mechatronic components; Idle control; Waste gate and VVT actuators; AI/AO, DI/DO signals on uC; Digital signal acquisition; Peripheral uC devices; uC Communication interfaces; uC Hardware; Specific features of IC Engine uC; IC Engine specific functions realized on TPU blocks of Motorola (Freescale) uC; Software and programming methods - development environment, compiling, debugging; Software testing - SIL, PIL, HIL; Automatic control (basic principles repetition); Air/Fuel ratio control; Knock control; Adaptive control algorithms; Principles of Model Based IC Engine control and diagnostics; Engine speed based diagnostics and control algorithms; ICE ECU communication interfaces; Automotive communication buses and protocols - CAN, LIN, Flex Ray, K-Line, CCP;

**practical teaching**

In vivo demonstration of IC Engine mechatronic systems; Exercises with various automotive, IC Engine specific, sensors and actuators; uC programming (Freescale MPC 566, and MC68332) - basic ICE (gasoline fuel injection) control application based on TPU functions; SIL and PIL simulations; CAN communication - ECU calibration via CCP; IC Engine sensors and digital acquisition - Calculation tasks;
prerequisite

Exams passed on course “Electrical and electronics engineering” and at least one of: “ICE Fundamentals”, or “Engine fuelling and ignition systems”

learning resources

1. S.J. Popović, N. Miljić Handouts
2. IC Engine testing Laboratory (with an engine on the test bed)
4. Phytec pc-565 (Freescale MPC 565)
5. MCT GmbH Mega332 (Freescale MC68332)
7. Metrowerks CodeWarrior 8.x
8. WinEco MCT GmbH

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 14
laboratory exercises: 12
calculation tasks: 3
seminar works: 0
project design: 0
consultations: 1
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 2
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 6
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 30
laboratory exercises: 15
calculation tasks: 15
seminar works: 0
project design: 0

296
final exam: 40
requirements to take the exam (number of points): 30

references


**Interior Ballistics**

**ID:** MSc-1137  
**responsible/holder professor:** Micković M. Dejan  
**teaching professor/s:** Jaramaz S. Slobodan, Micković M. Dejan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 4  
**final exam:** written  
**parent department:** weapon systems  
**semester.position:** 2.2

**goals**

Study of methods of solving the basic task of interior ballistics and ballistic design. The study of the basic characteristics of special types of weapons. Consideration of methodology of interior ballistic tests.

**learning outcomes**

Mastering the calculation of direct and indirect task of interior ballistics of various types of weapons, and the methodology of interior ballistic tests.

**theoretical teaching**

Introduction to interior ballistics.  
Gun propellants and their characteristics.  
Basic processes and laws during firing.  
Solution of the basic task of interior ballistics (Task statement. The analytical method of solving. Propellant gas temperature calculation. Tabular method of solving the basic task of interior ballistics).  
Ballistic design.  
The solution of the task of internal ballistics for the combined (howitzer) charge.  
Interior ballistics of recoilless weapons.  
Interior ballistics of mortars.  
The introduction of interior ballistic corrections (Ermolaev method).  

**practical teaching**

Production of gunpowder.  
Basic processes and laws during firing.  
Solution of the basic task of interior ballistics (Task statement. The analytical method of solving. Propellant gas temperature calculation. Tabular method of solving the basic task of interior ballistics).  
The solution of the task of interior ballistics for the combined (howitzer) charge.  
Introduction of interior ballistic corrections (Ermolaev method).

**prerequisite**
Passed exams (preferred): Thermodynamics B, Fundamentals of Projectiles Propulsion, Physics of Explosive Processes

**learning resources**

2. Interior ballistic design tables
3. Correctional coefficients tables

**number of hours**

total number of hours: 45

**active teaching (theoretical)**

lectures: 18

**active teaching (practical)**

auditory exercises: 4
laboratory exercises: 0
calculation tasks: 4
seminar works: 0
project design: 8
consultations: 2
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 2
colloquium, with assessment: 2
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 30
requirements to take the exam (number of points): 35

**references**
Introduction to nanotechnology

ID: MSc-1009

responsible/holder professor: Matija R. Lidija

teaching professor/s: Vasić-Milovanović I. Aleksandra, Matija R. Lidija

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 2

final exam: written

parent department: control engineering

semester.position: 2.2

goals


learning outcomes

Upon successful completion of this course, students will be able to:

• Establish the difference between physical and biological processes at the nano level, as well as micro and macro systems
• Define and calculate the basic characteristics of micro and nano systems
• Establish the difference and define the basic principles of devices used for the characterization of nano-materials
• Define the basic methods for computer simulation and optimization of nano systems

theoretical teaching


practical teaching

nonspecific and noncovalent interactions. Practical aspects and examples of application of biological and technical nano systems. Introduction to instrument assembly for nano system synthesis and introduction to nanorobotic assembly.

prerequisite

Prerequisite for attending this course is that student is regularly attending MAS first semester.

learning resources


number of hours

total number of hours: 30

active teaching (theoretical)

lectures: 12

active teaching (practical)

auditory exercises: 6
laboratory exercises: 3
calculation tasks: 0
seminar works: 1
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 1
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 3
final exam: 2

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 20
project design: 0
final exam: 40
requirements to take the exam (number of points): 35

**references**

Wiesendanger R.: Scanning Probe Microscopy and Spectroscopy, University of Hamburg, 1994
Machine design of pumps, fans and turbocompressors

ID: MSc-0445  
**responsible/holder professor:** Nedeljković S. Miloš  
**teaching professor/s:** Nedeljković S. Miloš  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** hydropower engineering  
**semester.position:** 2.2

goals

Mastering knowledge of engineering design of pumps, fans and turbochargers. Capacity to work in the design and development offices in the industry of pumps, fans, blowers and turbochargers. Training for innovation of design methods.

learning outcomes

After finishing this course, the students will be able to:
1. Conduct design calculations of pumps, fans and turbocompressors, applying different methods.
2. Make analysis of consequences of different approaches in design.
3. Use and analyze hydraulic, numerical and empirical data used in design calculations.
4. Model the geometries of pumps, fans and turbocompressors.

theoretical teaching


practical teaching

prerequisite

Subjects passed: Pumps, Fluid Mechanics B. Knowledge of basic computer tools.

learning resources

Handouts for lectures and exercises. Laboratory for hydraulic machines - equipment, installations, measuring equipment. Faculty computer classroom.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 5
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 22
consultations: 3
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 10
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 70
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 21

references
Mechanism and Handling Design in Food Industry

ID: MSc-0607
responsible/holder professor: Miladinović D. Ljubomir
Teaching professor/s: Jelić V. Zorana, Miladinović D. Ljubomir
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: theory of mechanisms and machines
semester.position: 2.2

goals

The students to master the skills of designing and constructing the cam and Maltese mechanism. To acquire the ability to analyze them in the machines and devices used in the food industry. To become familiar with the types and working methods of handling systems, as well as the design possibilities of these structures to obtain simple functions.

learning outcomes

The student has mastered the procedures for the construction of mechanisms that are mainly used in machinery and equipment in the food industry as well as to connect the work of individual machines in production lines. The student is familiar with the principles of a Working Model and thus can easily master other software package for modeling and generating mechanisms.

theoretical teaching

A brief review of the kinematic pairs and planar mechanisms; equivalent mechanisms. Cam mechanism, cam plate: translational and rotating; translational and rotating lifter - rounded, with rollers or disc; law of motion, velocity, acceleration, force, synthesis of cam plate. Maltese mechanisms, mechanisms with a toothed wheel and jumper; law of motion, velocity, acceleration, force, the mechanism synthesis . Spatial mechanism; mechanism structure , closed and open kinematic chains, mechanisms with a number of independent drives. Handling system with kinematic pairs of 5-class, a three-member spatial kinematic chains with independent drives; handling systems of type: TTT, TRT, TRR, and RRR RRT and servicing space. Creating a part of a software program for the optimal synthesis of mechanisms in MATLAB for special types of orbits of plane mechanisms. Drive synthesis for spatial handling systems; creating these types of manipulators in the Working Model; defining the desired motion path of the workpiece: 1-with an expression, 2-with a series of oriented positions, reading the law of internal coordinates of a handling system; defining a drive for a handling system.

practical teaching

Equivalent mechanisms; replacing the higher kinematic pair with a kinematic chain with a lower kinematic pairs. Design of a cam plate; generation of diagrams: time, speed and acceleration; use of the ACAD program in the synthesis of cam mechanisms. Design of a Maltese mechanism; selection of a Maltese mechanism; motion, velocity and acceleration diagrams; defining parameters for a toothed wheel and jumper. Design of of a mechanism with a specific path; mechanism synthesis using MATLAB and design in Working Model for a specified path. Design of TTT, TRT, ... handlin systems using Working Model; defining independent drives, determination of forces in kinematic pairs; defining driving forces and
moments. Handling System of type TTT, TRT, ...design, according to the given displacement of the workpiece (or a series of oriented positions).

**prerequisite**

To attend classes of the subject Mechanism and Handling Design in Food Industry, no condition is necessary.

**learning resources**

A. Sekulić: Mechanism Design  
B. Gligorić: Mechanisms  
Working Model Software Package

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 11  
laboratory exercises: 19  
calculation tasks: 0  
seminar works: 0  
project design: 0  
consultations: 0  
discussion and workshop: 0  
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0  
check and assessment of lab reports: 0  
check and assessment of seminar works: 0  
check and assessment of projects: 0  
colloquium, with assessment: 10  
test, with assessment: 0  
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0  
test/colloquium: 35  
laboratory exercises: 15  
calculation tasks: 0  
seminar works: 0  
project design: 20  
final exam: 30  
requirements to take the exam (number of points): 35
references
Nonlinear Systems 1

**ID:** MSc-0628  
**responsible/holder professor:** Jovanović Ž. Radiša  
**teaching professor/s:** Jovanović Ž. Radiša  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** control engineering  
**semester.position:** 2.2

**goals**

- Introduction to nonlinearities in the plants and processes.  
- Introduction to basic concepts of analysis of nonlinear systems.  
- Understanding and using the basic tools for testing the stability of nonlinear systems.  
- Analysis of nonlinear systems using Matlab and LabView programming software.

**learning outcomes**

Knowledge and understanding of:  
- Nonlinear problems and phenomena in the processes and plants.  
- Mathematical description of nonlinear systems.  
- Basic methods for analyzing nonlinear systems in the time domain and state space.  
- Simulation and analysis of nonlinear systems using a PC and programming software Matlab and LabView.

**theoretical teaching**


**practical teaching**

**PA:**  

**PL:**  
Practice and experiments: verification of non-linear mathematical models of different objects using a PC; experimental determination of nonlinear static characteristics and analysis of the dynamic behavior of different objects of automatic control (DC servo motor, heat flow experiment, coupled tanks experiment) using the programming software Matlab/Simulink and LabView.
prerequisite

Defined by curriculum of the study programme.

learning resources

• Lj. Grujić, D. Lazić, Nonlinear Systems, Lecture notes in electronic form
• Radiša Jovanović, Nonlinear Systems 1, Lecture notes
• Radiša Jovanović, Matlab and Simulink in Automatic Control, Faculty of Mechanical Engineering, Belgrade, 2016.
• Modular educational real time control system with various control plants (DC servo motor, inverted pendulum, double inverted pendulum, heat flow experiment, coupled water tanks experiment), with acquisition hardware and software,
• Electrohydraulic control system,
• PC and PC Embedded controllers, Siemens Simatic PLC, National Instruments controllers,
• Installation for control system testing and acquisition of electrical variables,
• Automatic Control Laboratory, Intelligent Control Systems Laboratory, Control Systems Laboratory.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 20
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 3
check and assessment of lab reports: 3
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 50
laboratory exercises: 5
calculation tasks: 10
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references

Programmable Control Systems

ID: MSc-0904
responsible/holder professor: Jakovljević B. Živana

Teaching professor/s: Jakovljević B. Živana

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: written

parent department: information technologies

semester.position: 2.2

goals

The objective of this course is that students: acquire necessary knowledge in application, design, programming and implementation of programmable control systems in industry and contemporary manufacturing; master the skills for practical problem solving in industrial control using computer, information and control technologies and appropriate scientific methods

learning outcomes

After successfully completing this course, the students should be capable to:
- Analyze social, economic, production and other effects of programmable control systems;
- Integrate knowledge in related subjects and implement them in programmable control systems design;
- Analyze and synthesize combinational automata;
- Synthesize sequential automata;
- Carry out electro-pneumatic realization of combinational and sequential automata;
- Program programmable logic controllers according to IEC 61131-3;
- Program NC machine tools according to ISO 6983 for machining tasks of low complexity.

theoretical teaching

1. Programmable and computer control systems in automation: CNC control, robot controllers, programmable controllers, controllers in programmable automation and computers.
2. Number systems and codes: positional number systems (decimal, binary, octal, hexadecimal); conversion of numbers between positional number systems; binary coded decimal; Gray code; alphanumerical codes
3. Switching algebra: axioms of Boolean algebra; elementary operations of switching algebra; theorems of switching algebra; logic functions; canonical forms of logic functions (sum of minterms and product of maxterms); minimization of logic functions
4. Technologies and components: sensors and actuators
5. Combinational and sequential automata: definition, models, synthesis and analysis; Electro-pneumatic realization
6. Programmable logical controllers: functions, hardware, software, input-output modules; programming languages and programming according to IEC 61131-3.
7. CNC control: hardware, software, functions, mathematical models; interpolation and internal computation; operation panel, human machine interface, programming using ISO 6983 and ISO 14649 (STEP-NC).
practical teaching

1. Auditory exercises: examples in automation design, with control system analysis and synthesis, programmable controllers programming, and control scheme design.
2. Laboratory exercises:
   - PL1 Control of pneumatic actuators
   - PL2 Synthesis of combinational automaton (electro-pneumatic realization using PLC)
   - PL3 Synthesis of sequential automaton (electro-pneumatic realization using PLC and programming in ladder diagram)
   - PL4 Synthesis of sequential automaton (electro-pneumatic realization with PLC- timers and counters)
   - PL5 Synthesis of sequential automaton (electro-pneumatic realization using PLC and programming in sequential function charts)
   - PL6 Programming of NC machine tools according to ISO 6983; program generation and machining of part using selected machining system
3. Seminar work: examples of programmable systems design with analysis, synthesis, programming, and control scheme design.

prerequisite

none

learning resources

2. Pilipović M., Manufacturing processes automation: Laboratory. FME, Belgrade, /In Serbian/
4. Laboratory desk with electro-pneumatic components and programmable controllers, Laboratory for manufacturing automation.
7. Software for programmable controller programming, Laboratory for manufacturing automation.
8. CNC and robot control units, Cent

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 12
calculation tasks: 0
seminar works: 6
project design: 0
consultations: 2
discussion and workshop: 0
research: 0
knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 4
check and assessment of seminar works: 2
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 4
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 20
laboratory exercises: 10
calculation tasks: 0
seminar works: 15
project design: 0
final exam: 50
requirements to take the exam (number of points): 30

references

Rail vehicles 2

ID: MSc-1188  
**responsible/holder professor:** Milković D. Dragan  
**teaching professor/s:** Milković D. Dragan, Simić Ž. Goran  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** railway mechanical engineering  
**semester.position:** 2.2

**goals**

1. Understanding different constructions of the freight wagons and passenger coaches  
2. Acquiring the knowledge necessary to understand the functioning of wagon or coach assemblies  
3. Application of knowledge in the design, development, repair and maintenance of wagons and coaches

**learning outcomes**

After completion of the course the student should be able to:  
1. Explain the functional and structural characteristics of various types of rolling stock.  
2. Explain the tasks and functioning principles of the assemblies of the rail vehicles.  
3. Identify actions required to resolve failures in operation and maintenance of rail vehicles.  
4. Apply appropriate regulations and standards for design and maintenance of railway vehicles.  
5. Apply computer tools for calculating and designing rail vehicles.

**theoretical teaching**


**practical teaching**


**prerequisite**
Previously passed course Railway vehicles 1.

**learning resources**

D. Milkovic, Rail vehicles, hand-out
G. Simic, Instructions for writing student papers, hand-out
For preparation tasks as a basis should be used the appropriate regulations and standards

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 6
laboratory exercises: 2
calculation tasks: 0
seminar works: 3
project design: 9
consultations: 5
discussion and workshop: 5
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 6
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 5
project design: 30
final exam: 35
requirements to take the exam (number of points): 0

**references**
Refrigeration Systems

ID: MSc-1117
responsible/holder professor: Milovančević M. Uroš
teaching professor/s: Milovančević M. Uroš
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: thermal science engineering
semester.position: 2.2

goals

Achieving of competence and academic skills as well as methods for their acquisition. The development of creative abilities and practical skills which are essential to the profession. Objectives are concrete and achievable and in full accordance with the defined basic tasks and objectives of the study program.

learning outcomes

Student acquires subject-specific abilities that are essential for the quality of professional activities: analysis, synthesis and prediction of solutions and consequences; application of knowledge in practice; linking the basic knowledge in various fields with their application to solve specific problems.

theoretical teaching

Thermodynamic basis: Moist air, thermodynamic properties of moist air, Mollier's "h-x" diagram, Important psychometric processes, Dalton's and Lewis's Law of evaporation, Wet bulb temperature of moist air, Evaporation heat transfer calculation, Merkel's coefficient; Heat exchangers: NTU method, Heat exchanger characteristics; Characteristics of compressors; Condensers: Sizing of air-cooled, water-cooled and evaporative condensers; Evaporators: the process of refrigerant boiling, the processes on the cooled fluid side, Sizing of air cooling evaporators, Characteristics of evaporators; Analysis of complete vapour compression refrigeration systems.

practical teaching

Auditory training: Psychometric processes, Evaporation heat transfer; prediction of the compressor characteristic, sizing of condensers (air-cooled, water-cooled and evaporative), sizing of evaporators, evaporator characteristic calculation; Analysis of complete vapour compression refrigeration systems;
Laboratory exercise: demonstration of the installation in an industrial refrigeration plant;
Design project of refrigeration system: work in groups of 5 students (for a particular object and refrigerant), calculation and selection of elements of refrigeration plants, PI diagram of refrigeration plant.

prerequisite
Required exams passed: Refrigeration Equipment

**learning resources**

1. Textbook: M. Markoski: Refrigeration, Mechanical Engineering, 2006,
2. Handouts which are available in advance for each week of classes

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 15
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 50
requirements to take the exam (number of points): 21

**references**
Special techniques and technology of drying

**ID:** MSc-0795  
**responsible/holder professor:** Marković D. Dragan  
**teaching professor/s:** Marković D. Dragan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** agricultural engineering  
**semester.position:** 2.2

**goals**

Acquire basic knowledge in the field of special techniques and technologies of drying process (drying by radiation, osmosis, ultrasound, conductive, sublimation, in a stream of high and super high frequency, etc.), which includes the development of creative abilities and mastery of practical skills for specific job performance.

**learning outcomes**

After successful completion of this course, students should be able to:  
- Describe the transfer of heat and mass transfer in drying processes,  
- List and recognize the basic methods of drying,  
- are calculated drying processes and project solutions,  
- Determine the drying time,  
- Evaluate the optimal way of drying according to the type of agricultural materials, conditions and requirements for drying and storage.

**theoretical teaching**

1.0. Methods of extraction of moisture and classification of thermal energy to the drying characteristics. 2.0. Thermoradial drying: Thermoradial dryers with electrical and gas heating; Thermoradial dryer with an electric heating; Thermoradial dryers with gas as a heat source; Method of heat drying calculation for thermoradial dryers. 3.0. Contact drying of materials: Contact drying of the material by heating surface; Dryers for contact drying; Drying materials in liquid environments; The contact drying with a sudden change in pressure. 4.0. Molecular drying (sublimation drying of material): The mechanism and scheme of sublimation drying of material; Heat calculation of the basic apparatus of sublimation dryers; Vacuum dryers. 5.0. Drying in an electric field of high and super high frequency: Electricity consumption and the influence of humidity and frequency of electric field on intensity of drying with high frequency power; Drying generators with high frequency power and patterns of high-frequency dryers; Combined methods for drying of materials. 6.0. Drying in an acoustic (ultrasonic) field. 7.0. Drying process of osmosis. 8.0. Typical drying solutions in terms of construction and energy sources: Solar mobile dryers; Combined solar dryers; Solar systems, the Centers for drying; Farm (Park) of solar dryers. 9.0. Testing of the mobile, universal, ecological, solar drying chamber module for drying of biological materials: Mobile, universal, ecological, cabinet solar dryer for drying of biological materials; Description of measurement installations; The experiment process and display measurement results. 10.0. Drying of fruits and vegetables using solar energy; Drying of fruits using solar energy; Drying vegetables using solar energy; Packaging and storage of dried fruits and vegetables.
**practical teaching**

Practical work: Calculation tasks and seminar papers from these theoretical wholes in the aim of sizing characteristic solutions of some of the studied field area. Laboratory exercise: A study of drying material in thermoradial dryers. The aim of exercise is a study of the drying process characteristics and obtain the curve of drying and curve of drying speed. Seminary work from some of these theoretical wholes in order to introduce students to the existing solutions and their characteristics, and monitoring developments in the field.

**prerequisite**

Defined curriculum of study program / module

**learning resources**


**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 5
calculation tasks: 15
seminar works: 10
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 5
check and assessment of lab reports: 0
check and assessment of seminar works: 3
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 2
final exam: 5

**assessment of knowledge (maximum number of points - 100)**
feedback during course study: 20
test/colloquium: 10
laboratory exercises: 0
calculation tasks: 10
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references

Lykov V. M. (1970), Dying in the chemical industry, the publishing house "Chemistry", Moscow.
Thermal Power Plants

ID: MSc-0911
**responsible/holder professor:** Petrović V. Milan
**teaching professor/s:** Banjac B. Milan, Petrović V. Milan
**level of studies:** M.Sc. (graduate) academic studies
**ECTS credits:** 6
**final exam:** written+oral
**parent department:** thermal power engineering
**semester.position:** 2.2

**goals**

Getting to know the procedures for the selection of the type, parameters and configuration of the thermal power plant according to demand of energy consumption, available sources of primary energy, energy and economic performances and other important criteria. Also, learning on the performance and technological characteristics of individual technological systems in thermal power plants. Exercise program is based on the implementation of certain practical knowledge of the course program by solving of specific examples.

**learning outcomes**

On completion of this programme, it is expected that student will be able to
- identify different technological subsystems within the thermal power plant,
- projects technological scheme of thermal power plants with steam and gas turbines,
- conduct techno-economic analysis of the operation of thermal power plants, calculate the production price electricity and determine the economic feasibility parameters,
- calculate and optimize the condenser plant,
- determine the necessary flow of cooling water,
- perform calculation and optimization of feed water heater.

**theoretical teaching**

The influence of the main factors and criteria for the selection of the thermal power plant. The structure and characteristics of the final energy consumption. The choice of configuration and parameters of the thermal power plants: basic and main thermodynamic parameters for steam and gas power plants, thermodynamic improvements of steam and gas turbine power plants. Estimation of the cost of electrical energy production and the optimization criteria of the thermal power plants: the total costs of energy production, comparative cost factors as optimization criteria and indicators of economic viability. Power plant and a complex technological system. Technological scheme of thermal power plants. Technological scheme of the main system for the production of electricity that includes the start and stop function block. Other systems: fuel supply, drainage, transportation and disposal of ash and slag, condensation plant with a system for supplying cooling water, system for the control and management of steam plants.

**practical teaching**

Visits to power plant are planed to learn about the major technological power generation systems (steam turbine plant and boiler house) with the main auxiliary technological systems. Foresees a Three tasks related to the calculation of production costs and prices of unit of electricity, design of technological scheme of the main power plant cycle and the application of economic parameters to optimize the thermal power plant. Test of students
knowledge is planed by 3 tests in theoretical fields, examination and evaluation of calculation tasks and report on the visit to power plant.

prerequisite

Passed exams in Thermodynamics and Fluid mechanics

learning resources

Written manusscript.
2. Rižkin, V.: Thermal power Plants Energoatomizdat, Moskva, 1987.-KSJ

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 6
laboratory exercises: 5
calculation tasks: 17
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 8
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 2
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 20
seminar works: 0
project design: 0
final exam: 50
requirements to take the exam (number of points): 30

references

Kostyuk, A. and Frolov V.: Steam and Gas Turbines, Energoatomizdat, Mir Publishers
Moscow, 1988.
Transport and logistic systems design

ID: MSc-0119
responsible/holder professor: Kosanić Ž. Nenad
teaching professor/s: Kosanić Ž. Nenad
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: material handling, constructios and logistics
semester.position: 2.2

goals

Introducing the students into the advanced transport, warehouse and logistic (warehouse-distributive) systems design process logic is the main goal. Development of the student system design creative and innovative abilities in order to increase the material flow, warehouse and logistic activities efficiency, contributing to the overall country industrial development is also the main issue.

learning outcomes

Upon successful completion of this course, students should be able to:

- Specify elementary subsystems, elementary subsystem variables, elementary subsystem performance variables and environment variables of the flexible transport systems.
- Calculate the basic elementary subsystems performance variables (by queueing systems modeling) of the flexible transport and logistic systems.
- Make a comparison of different flexible transport system applications.
- Make a calculation of needed capacity, technological and additional storage equipment, working power, working places, needed areas and material flow of the storage and logistic systems.

theoretical teaching

System, elementary subsystem and environment variables and performance variables of the flexible transport system (FTS). FTS elementary subsystems. "Power and free" system main design characteristic. Flexible monorail system main design characteristic. Rail automated vehicle system main design characteristic. Automated guided vehicle system (AGVS) main design characteristic. Required flexible transport systems vehicle fleet estimation. Warehouse and logistic (warehouse-distributive) systems fundamental design characteristics: goods receiving subsystem, main warehouse subsystem, order picking subsystem, goods dispatching subsystem. One dimensional non strategy and strategy order picking models. Two dimensional order picking models. Case studies (with pointing out most important design parameters). Exercises of lectures.

practical teaching

Exercises of order picking models. Concept design of conventional warehouses with different warehouse technologies, hay-bay warehouses with different automation level and logistic (warehouse-distributive) systems: Goods receiving and dispatching subsystems area estimation, goods receiving and dispatching subsystems technology choosing, main warehouse subsystem technology choosing and capacity estimation, order picking subsystem technology choosing and capacity estimation; Storage equipment technical specification;
Required applied transport systems vehicle fleet estimation; System performance variable estimation; Storage system layout design; Warehouse and logistic systems design recommendation and consultation.

**prerequisite**

Needed: Passed Subject: Mathematical probability and statistics, Material handling equipment, Facility layout and industrial logistics.

**learning resources**


**number of hours**

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 10
seminar works: 5
project design: 20
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 2
check and assessment of projects: 3
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 20
final exam: 30
requirements to take the exam (number of points): 35

references

1, Dj. Zrnic, Facility layout design, Faculty of mechanical engineering, University of Belgrade, 1993.
2, Dj. Zrnic, M. Prokic, P. Milovic, Foundry layout design, Faculty of mechanical engineering, University of Belgrade, 1998.
3, Dj. Zrnic, D. Savic, Material flow simulation, Faculty of mechanical engineering, University of Belgrade, 1997.
4, Dj. Zrnic, D. Petrovic, Facility layout design solved example problems, Faculty of mechanical engineering, University of Belgrade, 1992.

Lecture Handouts
Brakes of rail vehicles

ID: MSc-1189
responsible/holder professor: Milković D. Dragan
teaching professor/s: Milković D. Dragan, Simić Ž. Goran
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: railway mechanical engineering
semester.position: 2.3

goals

1. Introducing the brake system of railway vehicles.
2. Acquiring the knowledge necessary to understand the functioning of rail vehicle brake system components.
3. Training for the application of knowledge in the design, development, repair and maintenance of the brakes.

learning outcomes

After completion of the course the student should be able to:
1. Explain the functional and design characteristics of various types of brakes.
2. Explain the tasks and functioning mode of brake system assemblies.
3. Identify actions required to be applied in case of malfunctions of the brake system during operation and maintenance.
4. Apply appropriate regulations and standards for design and maintenance of rail vehicle brakes.

theoretical teaching


practical teaching


prerequisite

It is recommended previously to pass course Railway vehicles 1.

learning resources

Milovanović, M., Lišanin, R., Brakes and braking of rail vehicles (in Serbian), Faculty of Mechanical Engineering, Belgrade 2000
Milovanović, M., Lišanin, R., Vukšić-Popović, M., Kržić, Đ., Brakes and braking of rail vehicles- basis for design, selection and and maintenance (in Serbian), Faculty of Mechanical Engineering, Belgrade 2007
For tasks realization shall be used the appropriate regulations and standards.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 14
laboratory exercises: 2
calculation tasks: 7
seminar works: 0
project design: 0
consultations: 3
discussion and workshop: 4
research: 0

knowledge checks

check and assessment of calculation tasks: 5
check and assessment of lab reports: 1
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 20
laboratory exercises: 10
calculation tasks: 30
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

references
Chemical and Biochemical Operations and Reactors

**ID:** MSc-0301  
**Responsible/Holder Professor:** Radić B. Dejan  
**Teaching Professors:** Obradović O. Marko, Radić B. Dejan  
**Level of Studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**Final Exam:** written+oral  
**Parent Department:** process and environmental protection engineering  
**Semester Position:** 2.3

### Goals

The purpose of the subject is for students to get knowledge about theories of kinetic and dynamic of physical-chemical transformations in various technological processes. Influence of process parameters to gaining conditions for physical and chemical equilibrium is separately considered. Getting knowledge about basic models of chemical reactors, types of chemical reactions, rules used for qualitative and quantitative description of complex physical-chemical phenomenon and mass and heat balance equation, gives students basic for independent projecting of technologies and systems of process industry.

### Learning Outcomes

Successful completion of the study program the student acquires the knowledge necessary to understand the kinetics of chemical reactions and to master the methodology of calculation of chemical processes and reactors. Introduction to basic models of chemical reactors and material equations and thermal balance should allow students to independently analyze the real process, that the application of engineering and scientific methods to be able to design processes and systems.

### Theoretical Teaching


### Practical Teaching

Calculations of ideal reactors (batch reactors, continuous stirred-tank reactors, plug flow reactors, cascade of continuous ideal reactors).
Comparison and selection of type of reactor.
Chemical reactor plant. Process optimization.

**prerequisite**

Defined by curriculum of study program/module

**learning resources**

2. Вороњец, Д., Кубуровић, М.: Thermodynamics of multicomponent systems and chemical thermodynamics, Faculty of mechanical engineering, Belgrade, 1991.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 20
laboratory exercises: 2
calculation tasks: 5
seminar works: 0
project design: 0
consultations: 3
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 3
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 7
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 25
laboratory exercises: 5
calculation tasks: 10
seminar works: 0
project design: 0
final exam: 50
requirements to take the exam (number of points): 28

references

Смирнов, Н.Н., Волжинскии, А.И., Химические реактори в примерах и задачах, Химија, Ленинград, 1986.
Composite Structures

**ID:** MSc-0639  
**responsible/holder professor:** Dinulović R. Mirko  
**teaching professor/s:** Dinulović R. Mirko, Simonović M. Aleksandar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** aerospace engineering  
**semester.position:** 2.3

### goals

1. Introduction to modern approach in stress analysis of composite material structures on aircraft, it's application to practical problems solutions as well as experimental methods applied to structural verification of composite structures.
2. Introduction to specifics of thin walled structures and application of composite materials for these structures.
3. Introduction to computer simulation and stress analysis of composite structures on aircrafts.

### learning outcomes

1. Starting from the mechanical properties of fibers and matrices to calculate the properties of the composite elastic lamina.
2. Calculate the load capacity of the composite lamina applying the HILL, Wu and Tsai criteria.
3. Using classical laminate theory (CLT) determine stress-strain state in composite laminate for a given external load.
4. Use commercial software for calculation of strength of aircraft composite structures.

### theoretical teaching


### practical teaching

In the practical part of the course, stress-strain theory applicable to composite media is demonstrated. Real practical problems are analyzed. Practical work is carried out using computers and finite element analysis software for composite materials structures. Students are provided with all necessary materials in the form of lecture notes, books and past exam and test papers.

### prerequisite

Recommendation: Theory of elasticity, Structural analysis of aircraft structures

### learning resources
Course notes in electronic form, media materials, computer simulation models available after class, internet resources.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10  
laboratory exercises: 0  
calculation tasks: 5  
seminar works: 0  
project design: 10  
consultations: 5  
discussion and workshop: 0  
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0  
check and assessment of lab reports: 0  
check and assessment of seminar works: 0  
check and assessment of projects: 5  
colloquium, with assessment: 0  
test, with assessment: 5  
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10  
test/colloquium: 20  
laboratory exercises: 0  
calculation tasks: 10  
seminar works: 0  
project design: 20  
final exam: 40

requirements to take the exam (number of points): 40

**references**

Engineering Mechanics of Composite Materials, D.Ishaii  
Composite Airframe Structures, Michael Chun-Yung Niu, Michael Niu
Construction optimization

ID: MSc-1033
responsible/holder professor: Rosić B. Božidar
teaching professor/s: Rosić B. Božidar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: general machine design
semester.position: 2.3

goals

The main goal of this course for the student is to give the necessary knowledge of:
• numerical analysis and optimization,
• understanding general principles of design optimization,
• formulating the optimization problems and identify critical elements,
• application of optimization methods on construction optimization.

learning outcomes

Upon completion of this course, students are able to successfully apply the theoretical and practical knowledge and are trained to:
• Formulate the optimization model of mechanical system, identify relevant optimization variables, define the functional limitations and appropriate criteria for the multiobjective structural optimization task.
• Identify the domains of practical application of relevant deterministic and stochastic variables, and to perform simulation and sensitivity analysis of a set of functional limitations due to the change of construction parameters,
• Select the best construction variant based on the established multiobjective optimization criteria,
• Recommend the process of decomposition of complex structural optimization models to less complex, and develop the appropriate application in MATLAB
• Analyze and apply one-dimensional and multi-dimensional numerical methods in the software package MATLAB,
• Apply and develop new optimization methods in order to determine the optimal set of parameters of the complex mechanical systems, individually or as part of an appropriate team.

theoretical teaching

problem. Inequality constrained optimization.
Basic ideas and algorithms for step size determination.


practical teaching

Consists of the auditory and laboratory exercises. Projects are main component of this course.

prerequisite

Knowledge of linear algebra and numerical mathematics. Computer programming in MATLAB. Some knowledge of basic machine elements and mechanics.

learning resources

Computer Usage: Students extensively use the computer and optimization toolbox using MATLAB program. Handout.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 6
laboratory exercises: 21
calculation tasks: 0
seminar works: 7
project design: 3
consultations: 0
discussion and workshop: 3
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 7
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 3
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 35
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

**references**

Conveying and Material Handling Machines

ID: MSc-0308
responsible/holder professor: Zrnić Đ. Nenad
teaching professor/s: Zrnić Đ. Nenad
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: material handling, constructios and logistics
semester.position: 2.3

goals

The main goal of this course is to acquaint students with material handling machines and conveying machines, types and design solutions and principles of work. The goal is to introduce students to master the practical skills needed to perform the engineering profession, such as the main machine parameters, load analysis, selection of drive units and calculation of the capacity.

learning outcomes

By completing this course student acquires ability to:
• determine bulk and solid materials characteristics
• determine conveying machine's throughput/capacity in accordance with project requirements and type of conveyed material
• calculate and choose conveyor drive
• calculate basic parameters and components of belt conveyor
• calculate basic basic parameters and components of apron conveyor
• calculate basic basic parameters and components of screw conveyor
• calculate basic basic parameters and components of bucket elevator

theoretical teaching

Determination of the transport capacity of material handling and conveying machines. Conveyors, belt conveyors, apron conveyors, flight conveyors, overhead conveyors, elevators, screw conveyors, oscillating conveyors, roller conveyors, gravity conveyors, hoppers, feeders and gates, ropeways, basic performances of machines, structural solutions, basic calculations. material handling machines with translator motion, bridge and gantry cranes, unloading bridges, container cranes, performances, operational principles, analysis of load, calculations. material handling machines with rotational motion, jib cranes, tower cranes, portal cranes in ports, performances, structures, mechanisms. Elevators and industrial trucks, forklifts, storage cranes.

practical teaching

Calculation of conveyors with belt pulling element, the contour calculation and selection of propulsion belt conveyors, calculation around conveyor sections, calculation of conveyors with chain pulling element, apron and flight conveyors, calculation of bucket elevators, roller conveyors, screw conveyors. Video presentations of modern design of material handling machines, analysis of the machine operation in system, automation of work.

prerequisite
The conditions are defined by the curriculum of the study program.

**learning resources**

1. Nenad Zrnic: Conveying and Material handling machines - Hanouts and written lectures, 2011, DVL.
2. Slobodan Tosic, Material handling equipment - Mechanization of transport, Mechanical Engineering, Belgrade, 1999, KDA.
3. Slobodan Tosic, D. Ostric: Cranes, Faculty of Mechanical Engineering, 2005, KDA.
4. Computers, Laboratory 516, ICT / CAH

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 0
calculation tasks: 15
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 10
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 60
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

**references**
Conveying and Material Handling Machines

**ID:** MSc-0308  
**Responsible/holder professor:** Zrnić Đ. Nenad  
**Teaching professor/s:** Zrnić Đ. Nenad  
**Level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**Final exam:** oral  
**Parent department:** material handling, constructions and logistics  
**Semester.position:** 2.3

**Goals**

The main goal of this course is to acquaint students with material handling machines and conveying machines, types and design solutions and principles of work. The goal is to introduce students to master the practical skills needed to perform the engineering profession, such as the main machine parameters, load analysis, selection of drive units and calculation of the capacity.

**Learning outcomes**

By completing this course student acquires ability to:

- determine bulk and solid materials characteristics
- determine conveying machine's throughput/capacity in accordance with project requirements and type of conveyed material
- calculate and choose conveyor drive
- calculate basic parameters and components of belt conveyor
- calculate basic basic parameters and components of apron conveyor
- calculate basic basic parameters and components of screw conveyor
- calculate basic basic parameters and components of bucket elevator

**Theoretical teaching**

Determination of the transport capacity of material handling and conveying machines. Conveyor, belt conveyors, apron conveyors, flight conveyors, overhead conveyors, elevators, screw conveyors, oscillating conveyors, roller conveyors, gravity conveyors, hoppers, feeders and gates, ropeways, basic performances of machines, structural solutions, basic calculations. Material handling machines with translator motion, bridge and gantry cranes, unloading bridges, container cranes, performances, operational principles, analysis of load, calculations. Material handling machines with rotational motion, jib cranes, tower cranes, portal cranes in ports, performances, structures, mechanisms. Elevators and industrial trucks, forklifts, storage cranes.

**Practical teaching**

Calculation of conveyors with belt pulling element, the contour calculation and selection of propulsion belt conveyors, calculation around conveyor sections, calculation of conveyors with chain pulling element, apron and flight conveyors, calculation of bucket elevators, roller conveyors, screw conveyors. Video presentations of modern design of material handling machines, analysis of the machine operation in system, automation of work.

**Prerequisite**
The conditions are defined by the curriculum of the study program.

**learning resources**

1. Nenad Zrnic: Conveying and Material handling machines - Hanouts and written lectures, 2011, DVL.
2. Slobodan Tosic, Material handling equipment - Mechanization of transport, Mechanical Engineering, Belgrade, 1999, KDA.
3. Slobodan Tosic, D. Ostric: Cranes, Faculty of Mechanical Engineering, 2005, KDA.
4. Computers, Laboratory 516, ICT / CAH

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 15
labatory exercises: 0
calculation tasks: 15
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 10
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 60
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

**references**
Database Systems

ID: MSc-0521
responsible/holder professor: Misita Ž. Mirjana
teaching professor/s: Misita Ž. Mirjana
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: industrial engineering
semester.position: 2.3

goals

The aim of this course is to prepare students for working with complex databases in production companies. The aim of this course is usage of industrial engineering methods and techniques in the creation of different database queries and scripts. Also, the aim of course is usage of complex database for improvement of decision-making process and management of business-production system.

learning outcomes

Upon successful completion of this course, students should be able to:
- use SQL language,
- write queries for application industrial engineering methods using SQL language (For example: The level of utilization of machine capacity, the efficiency of production processes, ABC analysis, etc.).
- Analyze the results obtained by the queries established for business analysis,
- Estimates of efficacy of queries a established for the different methods of industrial engineering.

theoretical teaching

2. Methods and techniques of industrial engineering - scripts in the SQL language. Defining the scripts for: rationalization of operating costs (QC diagram, critical point, ABC method) for calculating the machine capacity efficiency degree, and other scripts that involve application of industrial engineering methods and techniques in the analysis of operations of the relevant business-production system.

practical teaching

Design of database, tables and indexes. Using of SQL query. Operators and functions in the SQL language. For the relevant example in practice, by using SQL language, defining scripts for: rationalization of operating costs (QC diagram, critical point, ABC method) for calculating the degree of efficiency of machine capacity, and other scripts that involve application of industrial engineering methods and techniques in the analysis of operations of the relevant business-production system.

prerequisite

Enrolled 3rd semestar of Master study.

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learning resources

1. Handouts,
2. Computer classroom,
3. Software tool: MySQL,
5. Database from concrete enterprise, in order to get practice on real example.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 25
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 10
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 50
requirements to take the exam (number of points): 10

references
Beaulieu, A., Learning SQL, O'Relly Media, 2009.
Data Exquisite in Mechanical Engineering

**ID:** MSc-0510  
**responsible/holder professor:** Mitrović B. Časlav  
**teaching professor/s:** Bengin Č. Aleksandar, Vorotović S. Goran, Mitrović B. Časlav  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** information technologies  
**semester.position:** 2.3

**goals**

Course objective:

- Numerical and mathematical analysis capabilities for each measurement.
- Design and write programs for analyzing measurements.
- Comparison analysis of numerical data processing and analysis software.
- Implementation of PHP and JAVA Script.

**learning outcomes**

The acquired knowledge allows:

- That be entered professional do the measurements and determine the necessary and forward the required size,
- That the measurement is so mathematical, numerical and statistical analysis and then to be graphical and logical preparation for further analysis,
- That, using PHP or Java Script, or both, make software to perform accurate data processing which is a pre-determined mathematically.

**theoretical teaching**

BASIC THEORY OF SAMPLES. Population and simple sample with replacement and without returning. Sampling - the empirical distribution as a possible Code of Conduct of the population.

TREATMENT OF STATISTICAL BASIS  


IMMEDIATE MEASUREMENT ACCURACY Equal and unequal. Determining the value of
measured values. Determination of measurement error. Distribution law of random sizes.

INDIRECT MEASUREMENT ACCURACY OF EQUAL. Determining the average size of the errors of certain indirect measurement. Determining the size of the average error of certain indirect measurement of the same accuracy. The general case of indirect measurement of the system of equations equal accuracy.

INDIRECT MEASUREMENT ACCURACY unequal. Normal equations indirect measurements of unequal accuracy. Control in solving the normal equation of unequal accuracy.

CONDITIONAL MEASUREMENTS SIZE. The process of measuring the conditional correlations. The process of reducing the indirect measurements. Basic Theory of Correlation. Two-dimensional distribution laws of random sizes.

**practical teaching**

It consists of auditory, laboratory exercises that accompany the course.

**prerequisite**

Required: Basic computer culture based on the use of a PC, regardless of operating sistema.Osnovno knowledge of mathematical logic.

**learning resources**

Audience is available licensed software owned by the faculty. Listeners freeware software is available.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 20

**active teaching (practical)**

auditory exercises: 6
laboratory exercises: 21
calculation tasks: 0
seminar works: 7
project design: 3
consultations: 0
discussion and workshop: 3
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 7
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 3
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 35
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

**references**

Č. Mitrovic, S. Radojevic, The Data Exquisite in Mechanical Engineering, a textbook (in preparation) Faculty of Mechanical Engineering, Belgrade
Decision-making methods

ID: MSc-0302
responsible/holder professor: Miljković Đ. Zoran
teaching professor/s: Miljković Đ. Zoran, Petrović M. Milica
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: project design
parent department: production engineering
semester.position: 2.3

goals

The aim of the course is to train the students to make decisions in the process of product development and design by using mathematical-algorithm-based procedures and artificial intelligence techniques. Development of students' creative abilities in improving technical/technological characteristics of a product using methods based on conceptual design points out the optimum decision function based on intelligent agents.

learning outcomes

Students' learning outcomes of this course are:
• The complex use of IT technologies in decision-making.
• The implementation of developed software (MATLAB, BPnet, ART Simulator, AnyLogic, TRIZ, Flexy) in solving typical technological problems within decision-making methods based on paradigms of artificial intelligence.
• Autonomous selection of the methods based on application of artificial neural networks and genetic algorithms in seeking the optimal solution in the process of product development.
• Understanding the interaction of soft and hard real-time subsystems of mobile robot in decision-making during exploring by using reconfiguration of physical structure and intelligent behaviour programming in MATLAB.
• Capability for team work.

theoretical teaching


practical teaching

Conceptual design and decision-making variables (selected examples). Analysis of typical manufacturing problems in domain of decision-making (laboratory work). Algorithms of machine learning and knowledge-based presentation - decision tree induction. Software for simulation of artificial neural networks (laboratory work). Manufacturability of the product - design parameters based on material flow for chosen manufacturing process (programming in MATLAB); application of genetic algorithms in optimization (selected examples). Machine learning of material flow for chosen manufacturing process. Intelligent machines and
decision-making (programming in MATLAB) - reconfigurable mobile robots and machine learning (laboratory work). Examples of conceptual designed products with optimal performances, pointing out the application of advanced production technologies (project activities). Project design (design parameters, searching performances, and defining of a decision matrix and decision function).

prerequisite

Defined by Curriculum.

learning resources

[1] Z. Miljković, D. Aleksendrić, ARTIFICIAL NEURAL NETWORKS – solved examples with theoretical background (2nd ed.), Textbook, University of Belgrade, Faculty of Mechanical Engineering, 2018, 18.1 /In Serbian/
[4] Z. Miljković, M.M.Petrović, Handouts, University of Belgrade, Faculty of Mechanical Engineering, 2018, 18.1 /In Serbian/
[6] Z. Miljković, M.M.Petrović, Website for Decision-making methods (http://cent.mas.bg.ac.rs/), University of Belgrade, Faculty of Mechanical Engineering, 2018, 18.13
[8] Laboratory mobile robot prototype (Khepera II mobile robot with gripper and camera; LEGO Mindstorms NXT and LEGO Mindstorms EV3 Sets of reconfigurable mobile robots equipped with sensors and microcontrollers), Laboratory CeNT, University of Belgrade, Faculty of Mechanical Engineering, 18.12
[9] Laboratory model of designed manufacturing system, Laboratory CeNT, University of Belgrade, Faculty of Mechanical Engineering, 18.12

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 16
calculation tasks: 0
seminar works: 0
project design: 9
consultations: 5  
discussion and workshop: 0  
research: 0  

**knowledge checks**

check and assessment of calculation tasks: 0  
check and assessment of lab reports: 0  
check and assessment of seminar works: 0  
check and assessment of projects: 3  
colloquium, with assessment: 3  
test, with assessment: 4  
final exam: 5  

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10  
test/colloquium: 25  
laboratory exercises: 0  
calculation tasks: 0  
seminar works: 0  
project design: 35  
final exam: 30  
requirements to take the exam (number of points): 30

**references**

Fans and turbocompressors

**ID:** MSc-0809  
**responsible(holder professor):** Čantrak S. Dörde  
**teaching professor/s:** Čantrak S. Dörde  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** hydropower engineering  
**semester.position:** 2.3

**goals**

Mastering knowledge of engineering applications of fans and turbocompressors as machines for raising of fluid energy. Capacity to work in practice on energy installations, as well as design of installations that include a fan or turbocompressor as built-in element with its function.

**learning outcomes**

Upon successful completion of this course, students should be able to:
1. identify and describe the various types and constructions of the fans and turbocompressors, the principles of their work, as well as the standard way of their installation,
2. determine the duty points of the ventilation system and fan,
3. select the appropriate fan and the most energy efficient way of its regulation,
4. determine the duty point of the fan by using the dimensionless parameters (characteristic coefficients),
5. calculate the fan characteristics when working with other fluid density,
6. calculate the thermodynamic and energy parameters of the turbocompressor,
7. design and develop (with the help of CNC and 3D printers) the 3D model of multistage axial compressor, with special emphasis on the impeller blades and guide vanes.

**theoretical teaching**


**practical teaching**

1. Auditory exercises:

2. Project design:
2.1. Presentation of the manual for multistage axial compressor design: from calculation of basic dimensions to 3D model.
2.2. Introduction to the application of the existing softwares for turbocompressor design.

3. Laboratory exercises:
3.1. Demonstration:
Laboratory for hydraulic machines - constructions of fans and turbocompressors and description.
3.2. Active laboratory exercises:
1. Testing of the fan performance curves.
2. Determination of sound power levels of noise sources (fan) using sound pressure.
3. Fan electrical motors and regulators wiring and starting the machines.

prerequisite

Completed courses: Fluid Mechanics B and Thermodynamics B.

learning resources

1. Textbooks listed in the references and list of literature provided for students.
2. Lectures and exercises handouts.
4. Laboratory for hydraulic machines - fans and turbocompressors, installations, measuring equipment.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 12
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 5
consultations: 3
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 3
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 10
Colloquium, with assessment: 0
Test, with assessment: 0
Final exam: 5

Assessment of knowledge (maximum number of points - 100)

Feedback during course study: 0
Test/colloquium: 50
Laboratory exercises: 5
Calculation tasks: 0
Seminar works: 0
Project design: 15
Final exam: 30
Requirements to take the exam (number of points): 21

References

Obradović N. (1974): Turbocompressors, Faculty of Mechanical Engineering University of Belgrade, Belgrade. (in Serbian)
Fundamentals of Air Conditioning

ID: MSc-1118
responsible/holder professor: Sretenović A. Aleksandra

teaching professor/s: Živković D. Branislav, Sretenović A. Aleksandra

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: written+oral

parent department: thermal science engineering

semester.position: 2.3

goals

Getting knowledge in Air Conditioning - thermal comfort, heat gain and cooling load, air handling unit and its elements, mastering methods for calculating cooling loads for non-stationary conditions of heat transfer and using those methods in air conditioning project design.

learning outcomes

Upon successful completion of the course, students should be able to:
- Understand influence of indoor thermal conditions on human thermal comfort
- Identified the process of unsteady heat transfer through the building envelope and inside air conditioned space
- Perform cooling load calculation for air conditioned buildings
- Select the appropriate amount of air for airconditioning system
- Carry out the selection of air handling unit elements heaters, coolers, humidifiers)
- Compare the characteristics of different systems for air filtration

theoretical teaching

Defining air conditioning; thermal ambiance conditions; thermal comfort in closed spaces; thermal regulation; meteorology and climate; Solar constant; atmosphere clearance; radiation on horizontal and vertical surfaces; outside and inside heat sources; heat transfer through single-layer and multiple-layer walls in non-stationary conditions of heat transfer; heat gains from solar radiation through window; heat storage factors; protection from solar radiation; shading effect on cooling load; heat gains from internal sources; calculation air flow rate for air conditioning; air treatment in air handling unit; air handling unit and its elements; heating and cooling coil; heat output control of heating and cooling coil; spraying chamber; evaporator; filtration; filter efficiency;

practical teaching

Auditory part consists of more sections: basic and complex processes in Molier h-x diagram, calculating cooling load from inside and outside heat sources, calculating airflow rate for air conditioning, defining air parameters in summer and winter operating mode, in order to independently complete project assignment. Laboratory exercise is demonstrative - air handling unit and its elements, air conditioning accessoris. Visit to Technical fair or factory for air conditioning equipment is planned.

prerequisite

In order to attend this subject, it is needed to pass exams: Thermodynamic and Fluid
mechanics.

learning resources

Handouts

B. Todorovic: Air conditioning

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 15
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 50
requirements to take the exam (number of points): 21

references
ASHRAE Handbook of Fundamentals, Atlanta, Georgia, 2009
Gas Turbines

**ID:** MSc-0300  
**responsible/holder professor:** Petrović V. Milan  
**teaching professor/s:** Petrović V. Milan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** thermal power engineering  
**semester.position:** 2.3  

**goals**

1. The achievement of academic competence in the field of gas turbines and thermal power plant engineering.  
2. Mastery of theoretical knowledge about how to transform heat into mechanical work of thermodynamic processes and equipment (gas turbines and gas turbine power plants).  
3. The acquisition of practical skills for design and optimization of gas and gas turbine cycle.  
4. Mastering the techniques of process modeling.

**learning outcomes**

1. Academic deep knowledge of the thermodynamic cycle and flows in gas turbines and gas turbine plants  
2. The development of critical thinking about energy use, fuel efficiency and environmental preservation  
3. The ability of calculate heat balance diagrams and main parameters of the gas turbine power plants.  
4. Ability to use computer technology for modeling and calculations

**theoretical teaching**

Theoretical teaching is carried out through 10 teaching modules:  
1. Thermodynamic basis of the gas turbines power plants. The basic thermodynamic cycles.  
2. The basic and main thermodynamic parameters of the gas turbine plants.  
3. The influence of basic parameters on the performance of the gas turbine plants. The choice of optimal parameters of the gas turbine plants.  
7. The application of gas turbines in the energy and airplane propulsion.  
10. Operating characteristics of gas turbines - change mode. Regulation of gas turbines.

**practical teaching**

Practical training is carried out through:  
Auditory exercises:  
Basic principles. Historical development. Classification, properties and applications of gas
turbines.
The application of gas turbines for the propulsion of vehicles, ships, rail.
Instructions for project 1: Calculation of the gas turbine thermal cycle (heat balance diagram)
of the gas turbine plants.
Instructions for project 2: Calculation of the combined cycle with gas turbine and steam
turbine (CCGT).
Project development:
Calculation of heat balance of the gas turbine power plant.
Calculation heat balance diagram of combined cycle with gas turbine and steam turbine.
Labs:
Introduction in principles of operation and design of gas turbines in the Laboratory for steam
and gas turbines

**prerequisite**
Passed exams in Thermodynamics and Fluid mechanics

**learning resources**

Petrovic, M. scripts and handouts for Gas turbines
Instructions for performing laboratory exercises
Software package for calculating of properties of combustion products

**number of hours**

Total number of hours: 75

**active teaching (theoretical)**

Lectures: 30

**active teaching (practical)**

Auditory exercises: 10
Laboratory exercises: 4
Calculation tasks: 0
Seminar works: 0
Project design: 13
Consultations: 0
Discussion and workshop: 3
Research: 0

**knowledge checks**

Check and assessment of calculation tasks: 0
Check and assessment of lab reports: 1
Check and assessment of seminar works: 0
Check and assessment of projects: 7
Colloquium, with assessment: 0
Test, with assessment: 2
Final exam: 5
assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 10
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 50
requirements to take the exam (number of points): 25

references

Stojanovic, Thermal Turbomachinery, Gradjevinska knjiga, belgrade, 1967.
Liear systems synthesis

ID: MSc-1068  
responsible/holder professor: Ribar N. Srđan  
teaching professor/s: Ribar N. Srđan  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written  
parent department: control engineering  
semester.position: 2.3

goals

Students meet the basic requirements for the design of control systems and to first in the form of knowledge of basic work indicators as a system in steady state and in transient operating modes. Students meet a wide range of modern methods for the design of real control systems.

learning outcomes

To know, accept and overcome some of the offered method for designing control systems and to be trained to implement them in every particular case, the class studied system. Furthermore it is expected that application of the method of designing control systems that take place in real time on the facilities and processes for a class of linear systems with feedback.

theoretical teaching


practical teaching


prerequisite

Automatic control examine passed

learning resources

D. L J. Debeljković, "Examples in the design of linear systems", Faculty of Mechanical Engineering, Belgrade, 1994 R. Milojković, D. L J. Debeljković, "Design of linear systems"

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 6
project design: 4
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 2
check and assessment of projects: 4
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 20
project design: 10
final exam: 30
requirements to take the exam (number of points): 30

**references**

B. R. Milojković, D. L J. Debeljković, "Design of linear systems", Faculty of Mechanical Engineering, Belgrade, 1981
D. L J. Debeljković, V. S. Mulić, Synthesis of Linear System Čigoja press, Belgrade 2002
Written copies of the lectures
Missile guidance and control

**ID:** MSc-1085  
**responsible/holder professor:** Todić N. Ivana  
**teaching professor/s:** Todić N. Ivana  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 2  
**final exam:** written  
**parent department:** weapon systems  
**semester.position:** 2.3

**goals**

Acquiring basic knowledge in the field of missile guidance and control with the possibility of applications in the fields of research and development, designing, manufacturing, marketing, operational use and analysis of modern guided missiles. Mastering the methodology of the calculations of dynamic characteristics of guided missiles (maneuverability, stability, etc. The eigen frequencies.) and autopilot synthesis and guidance law for the method of proportional navigation.

**learning outcomes**

The student acquires general knowledge in the areas of analysis and synthesis system of guided missiles that enables participation and communication in work teams involved in the development of guided missiles. With the use of modern software tools developed in MATLAB and Simulink, are qualified for the trajectory calculation of guided missiles, aerodynamic transfer function calculation and the synthesis of the autopilot and the missile guidance system. It has a basic knowledge of verification and assessment of the quality of guidance system.

**theoretical teaching**

Introduction to the theory of guidance and control of the missiles (discusses the basic principles of guidance and control). Analysis of dynamic characteristics of missiles and calculation of aerodynamic transfer functions. Basic requirements and methods of designing autopilots (Block is dedicated to improving the dynamic properties of rockets by autopilot use). Theoretical basis of proportional navigation (We examine the proportional navigation as one of the fundamental laws of guidance)

**practical teaching**

The practical realization of guided missiles (analyzed various construction solutions of guided missiles to review the role of guidance and control subsystem. The application of MATLAB and Simulink in design). Designing pitch and roll autopilots. Simulation homing systems (applying SIMULINK program, students are trained in the selection parameters PN). The project of the system of homing missile (Project includes aerodynamic function transfer calculations and synthesis of the autopilot and homing system)

**prerequisite**

None.  
Passed exams (preferably): flight dynamics and aerodynamics of projectiles, Fundamentals of automatic control
learning resources

Cuk, D.: Lectures in course Missile guidance and control, Faculty of Mechanical Engineering, Belgrade, 2002 (handouts)

number of hours

total number of hours: 30

active teaching (theoretical)

lectures: 8

active teaching (practical)

auditory exercises: 7
laboratory exercises: 3
calculation tasks: 3
seminar works: 0
project design: 3
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 3
colloquium, with assessment: 0
test, with assessment: 0
final exam: 3

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 40
final exam: 50
requirements to take the exam (number of points): 25

references

Multiphase flow M

**ID:** MSc-0830  
**responsible/holder professor:** Crnojević D. Cvetko  
**teaching professor/s:** Lečić R. Milan, Crnojević D. Cvetko  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** fluid mechanics  
**semester.position:** 2.3

**goals**

In the field of multiphase flow is particularly important to study the problems such as fluidization, pneumatic conveying, hydraulic transport, pneumatic lifts, cavitation, evaporation, condensation and two-phase flow. The main objective of this course is to master the knowledge, calculation models and the relevant practical skills that treat problems of one-dimensional multiphase flow in pipes and channels.

**learning outcomes**

Student mastery of knowledge in the field of multiphase flow - a mixture of fluid and solid particles, or a mixture of different fluids. She meets and knows how to use: the characteristic shape of particles, different forms of bulk and mass concentration, physical properties of the mixture, the settling velocity, the critical speed of the fluid and characteristic current size of one-dimensional flow.

The main outcomes of the course is to meet and master the skills of the budget for the different classes of incompressible and compressible multiphase flows that take place with or without the exchange amount of heat, such as the application of appropriate calculation models which lead to the current basic engineering parameters: pressure, flow velocity, fluid flow and pressure drops in pipes and channels in specific currents in fluidized beds, hydraulic and pneumatic transport and pneumatic - hydraulic lift.

Using the acquired knowledge student knows that dimensioned pipeline system for transporting the mixture. An important part of learning outcomes is the introduction to the different modes of transport, choice and budget separator.

**theoretical teaching**


The laws of conservation of matter, momentum and energy equations of diffusion equations of motion of particles. Eulerian and Lagrangian approach to the study of multiphase flow.

The equations of one-dimensional multiphase flow in pipes. The forces acting on the bubble of gas and solid particles, Stokes solution. Definition of various different oncentrations.


PNEUMATIC CONVEYING. The application, advantages and disadvantages, and pneumatic

HYDRAULIC TRANSPORT. The rheology of the suspension. Laminar flow of the suspension in circular pipe. Hydraulic transport inhomogeneous mixture in a horizontal, vertical or oblique pipeline. Application and calculation pneumo-hydraulic lifts.

MULTIPHASE FLOW LIQUID-GAS: The speed of sound in a multiphase mixtures, isothermal and isentropic change of state in the gas phase.

Numerical calculation methods multiphase flow.

**practical teaching**

**prerequisite**

Regular attendance. It is desirable that the student has already passed the course Fluid Mechanics M.

**learning resources**

Book of the teachers (there are in the library). Laboratory equipment and installations.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 25
laboratory exercises: 3
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 8
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 35
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 50
requirements to take the exam (number of points): 10

references

Processing technology of agricultural products

ID: MSc-0600
responsible/holder professor: Marković D. Dragan
teaching professor/s: Marković D. Dragan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: seminar works
parent department: agricultural engineering
semester.position: 2.3

goals

1. Student should master the basics of the process of agricultural products (fruits, vegetables, animal products and grains).
2. Understanding the limitations and specific lines of production and food processing.
3. Introduction to the preparatory process technologies of processing agricultural products (cleaning, washing, sizing and sorting round).
4. Mastering how to process modeling and optimization processes of food preservation using high and low temperatures.
5. Acquiring knowledge about the procedures and equipment for sterilization and pasteurization of food products.
6. Acquiring knowledge about the procedures and devices for cooling and freezing of fruits and vegetables.
7. Understanding the technology of cooling fruits and vegetables.
8. Understanding the technological procedures for freezing and storing fruit and vegetables.
9. Introduction to methods and devices for thawing food product.

learning outcomes

After successfully completing of this course, students should be able to:
1. Define the technological operations of processing of agricultural products
2. Describe and analyze traditional and new technologies of animal products
3. Describe and analyze traditional and new technologies of fruit, vegetables and cereals
4. To model and optimize processes and equipment for sorting and preserving products
5. Manages the technological processes and equipment in industrial plants for the production and processing of food.
6. Applying the appropriate standards.

theoretical teaching

vegetables. Thawing.

**practical teaching**

Seminar papers
1. Analysis of technologies for producing and processing fruit,
2. Analysis of technology for production and processing of vegetables,
3. Analysis of technologies for production and processing of grains and seeds,
4. Analysis of technology, machinery and equipment for production and processing of meat and dairy products.

**prerequisite**

Attended courses of previous years of study and all the conditions defined curriculum of study program / module

**learning resources**


**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 4
check and assessment of projects: 0
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**
feedback during course study: 10  
test/colloquium: 40  
laboratory exercises: 0  
calculation tasks: 0  
seminar works: 20  
project design: 0  
final exam: 30  
requirements to take the exam (number of points): 50

references

Branislav P. Zlatković.: "The technology of processing and preserving of fruits", published by University of Belgrade, Faculty of Agriculture 2002.  
Sava Vujic. "Refrigeration", published by Faculty of Mechanical Engineering, University of Belgrade, 1996.  
PRODUCTION INFORMATION SYSTEMS

ID: MSc-0786  
responsible/holder professor: Puzović M. Radovan  
teaching professor/s: Mladenović M. Goran, Puzović M. Radovan  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written+oral  
parent department: production engineering  
semester.position: 2.3

goals

1. Acquisition of nowledge about the role and importance of computer-oriented information systems for planning and management of production systems  
2. Mastery of theoretical basics of contemporary information systems architecture  
3. Acquisition of practical knowledge for applications design and development in the domain of information systems for planning and management of production systems

learning outcomes

On successful completion of the course, students should be able to:

• Identify basic concepts in the sphere of computer-oriented information systems design and development.  
• Identify the application and role of contemporary database management systems.  
• Define sub-systems (modules) within the production system, documentation and information flows within the sub-system and their interactions within the overall system.  
• Design database logical structure for a corresponding technological sub-system with description of required attributes for each entity and links between the entities.  
• Use contemporary software tools in the design and development of production information systems.

theoretical teaching

Information systems for new concepts of production systems. Possible creation of contemporary concepts, such as CIM/CIE, TQM, Kanban system or MRP-II systems, as well as concepts of organizational structures, such as concepts of virtual enterprises, network production, e-production systems based on architectures of the system in the network environment. Processes in the client/server architecture are also the subject-matter of the course. Production system functional structure, its structuring primarily into subsystems of a production technological system: structural information management, technological information management, stock management, current business operations management, tools system management, transport management, maintenance management, all implying information modeling, database modeling, defining the object-link diagrams (EP diagram), DBMS choice, developing physical data model up to the application development level

practical teaching

The student acquires practical knowledge for the design and development of software applications in the domain of production systems planning and management. Using some of
the available software tools for creating a database, the student passes through all stages of developing new software application for a concrete subsystem. This means the analysis of defined functions of planning and management, design and detailed elaboration of the designed solution, its practical realization, testing and official presentation in front of the teacher and other students

**prerequisite**

There are no prerequisites

**learning resources**

Handouts in e-form /In Serbian/. Instructions for laboratory exercises /In serbian/. Instructions for project design /In Serbian/. One-student-one-computer scheme in a computer room. Software tool for application development (Oracle, MS Access, Progress,...)

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 15
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 3
colloquium, with assessment: 0
test, with assessment: 7
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 40
requirements to take the exam (number of points): 40

references

Handouts in e-form (In Serbian).
Milačić V.: 2 Production Systems, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, in 1982. (In Serbian)
Jorg Thomas Dickersbach and Gerhard Keller: Production Planning and Control with SAP ERP (2nd Edition)
Projectile design

**ID:** MSc-1138  
**responsible/holder professor:** Elek M. Predrag  
**teaching professor/s:** Elek M. Predrag, Jaramaz S. Slobodan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 4  
**final exam:** written  
**parent department:** weapon systems  
**semester.position:** 2.3

**goals**

The main objective of the course is that students understand the importance, the basic concepts and methods of projectile design as an integral part of the science of weapons systems. Students should understand the key ideas about the types and purpose of projectiles, safety in the use and mechanisms of action.

**learning outcomes**

Student gets contemporary knowledge about the main types of projectiles (high-explosive, armor-piercing, special) and the basics of their design. Student could use methods of calculation of different types of projectiles and their components.

**theoretical teaching**

1. Introduction to the projectile design. Basics of projectile safety during the movement in the gun barrel. Stress of projectile elements in the gun barrel.
4. Armor-piercing projectiles. The influence of the mechanical characteristics of the projectile and armor on the penetration process.

**practical teaching**

5. Term paper - Preparation of seminar work with the subject determined by arrangement with the student.
prerequisite

Passed exam (preferred): Physics of explosive processes.

learning resources


number of hours

total number of hours: 45

active teaching (theoretical)

lectures: 18

active teaching (practical)

auditory exercises: 4
laboratory exercises: 0
calculation tasks: 10
seminar works: 2
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 2
check and assessment of projects: 0
colloquium, with assessment: 2
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Ship Structures 2

**ID:** MSc-0197  
**responsible/holder professor:** Motok D. Milorad  
**teaching professor/s:** Momčilović V. Nikola, Motok D. Milorad  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** naval systems  
**semester.position:** 2.3

**goals**

A thorough explanation of the hull girder longitudinal strength calculation. An explanation of specific requirements that have to be met by the hull of the three most prominent ship types: a container ship, a bulk carrier and a tanker.

**learning outcomes**

The student should be able to practically perform hull girder longitudinal strength calculation according to classification societies’ rules. A thorough knowledge should be acquired of specifics, general conception and the hull structural members of tankers, bulkers and container ships.

**theoretical teaching**

The first part of the course considers basic principles and methodology of longitudinal strength calculation: determination of hull girder loading on the basis of specific buoyancy and specific weight per ship unit length; determination of geometrical characteristics of hull girder crosssection; computations of wave induced transverse force and bending moment using classification societies’ empirical formulas; analysis of the overall stress state. The second part of the course comprises basic structural members and specifics of the hull structure in a tanker, a bulk carrier and a container ship – their names, appearance, basic functions, conditions and loadings they undergo during exploitation, methods of construction.

**practical teaching**

A detailed prominent example is used to explain the procedure for hull girder longitudinal strength calculation according to classification societies’ rules. Within the framework of independent design project of “his own ship” the student determines: equivalent hull girder loading on the basis of specific buoyancy curve and specific weight curve per ship unit length; geometrical characteristics of hull girder cross-section; wave induced transverse force and bending moment using classification societies empirical formulas and conducts final analysis.
of the overall stress state.

**prerequisite**

Exam passed in Ship Structures 1.

**learning resources**

[1] Lectures are available in electronic form /In Serbian/
[2] A detailed prominent example of the project
[3] Various classification societies’ rules

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 9
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 17
consultations: 4
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 7
colloquium, with assessment: 0
test, with assessment: 3
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 15
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 50
requirements to take the exam (number of points): 35

**references**
Signal processing

ID: MSc-0303

responsible/holder professor: Lazić V. Dragan

teaching professor/s: Lazić V. Dragan, Matija R. Lidija

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: written

parent department: control engineering

semester.position: 2.3

goals

Introduction of basic concepts and knowledge related to discrete signals and systems analysis in time domain as well as in frequent domain, digital processing of analog signals, digital processing of discrete and stochastic signals, digital filter design. Concerning digital image processing, student is introduced to concept of digital image, image quality enhancement, frequency domain processing, morphological processing and image compression.

learning outcomes

Upon successful completion of this course, students will be able to:

• Apply software MATLAB in analysis and processing of the major electrophysiological and kinematic time series and in analysis of digital medical images
• Form and implement the program for signal acquisition and to properly choose parameters of acquisition system depending on the type of biomedical signal
• Master the application and the characteristics of Fourier transform (discrete Fourier transform, fast Fourier transform, Z-transform)
• Distinguish the basic characteristics of biomedical signals (EEG, EKG, EMG, joint angles, muscle forces, medical files ...) in time and frequency domain
• Select and apply different filtering methods depending on the characteristics of the signal being processed and the types of further applications of such signals
• Form a user interface for processing and displaying of signals, adequate presentations of time series, image and signal processing results in the time, frequency and time-frequency domain

theoretical teaching


practical teaching

**prerequisite**


**learning resources**

Auditory room equipped with computer, video beam, internet connection and accompanied inventory. Computer room with 30 computers with needed software installed.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 14
laboratory exercises: 14
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 3
check and assessment of seminar works: 4
check and assessment of projects: 0
colloquium, with assessment: 4
test, with assessment: 0
final exam: 4

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0  
final exam: 30  
requirements to take the exam (number of points): 35

references

Najarian, Kayvan, and Robert Splinter. Biomedical signal and image processing. CRC press, 2005.;  
Supercharging of IC Engines

**ID:** MSc-0856  
**responsible/holder professor:** Popović J. Slobodan  
**teaching professor/s:** Popović J. Slobodan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** internal combustion engines  
**semester.position:** 2.3

**goals**

Acquiring new knowledge on role and importance of turbocharging in IC Engines. Developing skills to calculate parameters of supercharging and match compressor/turbine to desired engine performance. Broadening knowledge of thermodynamics by studying compressor/turbine performance characteristics and processes occurring in intercooler. Broadening knowledge in machine design by studying specific issues of turbocharger design principles.

**learning outcomes**


**theoretical teaching**


**practical teaching**


b) Student Project Task: Calculation of Supercharging System and matching Compressor/Turbine Characteristics to desired IC Engine Performance.

c) Laboratory Task: - Testing Compressor on Test Bench;

**prerequisite**

Passed exam on course "IC Engines processes". Good practical knowledge of Matlab/Simulink
learning resources

1. M. Cvetić: Extracts from lectures (handouts) in e-form
2. S. Popović: Numerical examples, in e-form
3. IC Engine testing Laboratory (with an engine on the test bed)
4. Turbo-compressor Flow test bench
5. DAQ System: National Instruments PXI-1042-RT8186/5401/6123/6229/4070/6602/8461
7. Matlab/Simulink Software Package

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 5
laboratory exercises: 5
calculation tasks: 14
seminar works: 0
project design: 2
consultations: 4
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 2
check and assessment of lab reports: 3
check and assessment of seminar works: 0
check and assessment of projects: 3
colloquium, with assessment: 0
test, with assessment: 2
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 10
laboratory exercises: 10
calculation tasks: 15
seminar works: 0
project design: 15
final exam: 50
requirements to take the exam (number of points): 0

references
Vehicle Mechatronics

**ID:** MSc-0873  
**responsible/holder professor:** Popović M. Vladimir  
**teaching professor/s:** Vasić M. Branko, Popović M. Vladimir  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** motor vehicles  
**semester.position:** 2.3

**goals**

Course objectives are designed to meet the needs of the 21st century automotive industry for graduate students with the necessary skills and understanding in mechatronics. Students should be able to deal with a wide range of activities that include research, design, development and testing of mechatronic systems in motor vehicles.

**learning outcomes**

Upon successful completion of this course, students should be able to:
- explain the concept of mechatronics and mechatronic systems, with respect to vehicles;
- describe in a nutshell the function of all components of a vehicle mechatronic system;
- analyse and explain the specific nature of vehicle mechatronic systems (suspension systems, braking systems, power transmission systems, steering systems, integrated systems);
- analyze the problems when designing a vehicle mechatronic system;
- define the design process of a vehicle mechatronic systems (which includes the determination of future system goal and development of a functional mechatronic system scheme);
- simulate the operation of the designed mechatronic system, as well as to define the testing method for the system in question.

**theoretical teaching**

Theoretical part of the course comprises following units: introduction to mechatronics, sensors and actuators, anti-lock braking systems, stability control systems, steer-by-wire steering systems, active suspension systems, advanced driver-assistance systems (parts 1, 2 and 3).

**practical teaching**

Practical part of the course is focused on students's own mechatronic system project.

**prerequisite**

No special requirements.

**learning resources**

Handouts in digital form.

**number of hours**
total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 5
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 35
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 35
requirements to take the exam (number of points): 35

references

Handouts in digital form
-
Assembly systems

**ID:** MSc-0319  
**responsible/holder professor:** Petrović B. Petar  
**teaching professor/s:** Petrović B. Petar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** production engineering  
**semester.position:** 2.4

**goals**

1. Learning of systematic approach to the design and production of mechanical assemblies;  
2. Understanding assembly process and basic assembly operations;  
3. Impact of assembly process on product development – product structure and Design For Assembly techniques;  
4. Part mating process, modeling and understanding relationships between precision, sensitivity and flexibility;  
5. Basic concepts of assembly systems – manual, automatic and robotic systems; Assembly system design. Assembly workstation design issues;  
6. Performance and Economics of Assembly Systems;  
7. Product lifecycle and product disassembly.

**learning outcomes**

1. Understanding what is assembly, its role in production systems, and why it is important.  
2. Fundamental knowledge and engineering skills about: assembly sequence analysis and design of assembly process, design of automatic part feeding and orienting, design for assembly (DFA) techniques, dimensioning and tolerancing of parts and assemblies, design of manual and automatic assembly workstations and systems, product disassembly and its impact on product lifecycle design.

**theoretical teaching**

Theoretical background of industrial assembly systems is given through 10 lectures + introductory lecture:  
0. What is industrial assembly and its role in production systems,  
1. Assembly system structure and assembly process,  
2. Part mating theory of compliantly supported rigid parts,  
3. Joining techniques and processes,  
4. Feeding and material flow in assembly system,  
5. Assembly structure, sequencing and Design For Assembly,  
6. Manual assembly systems,  
7. Automatic assembly systems – rigid transfer lines,  
8. Automatic assembly systems – flexible assembly lines and robotic assembly cells,  
9. Performance and Economics of Assembly Systems, and  
10. Product lifecycle and disassembly technology.

**practical teaching**

Practical training is organized through laboratory exercises and project (team work) of assembly system design for selected product.
LAB 1: Quasi-static part mating – demonstration of passive compliant device RCC, demonstration of 6 DOF force/torque sensor, force sensor calibration, robot motion programming, measurement of part mating forces and identification of contact situations, comparison of experimentally evaluated results with theory.
LAB 2: Passive systems for feeding and orienting – vibratory bowl feeder and linear feeding tracks demonstration, part geometry analysis and identification of basic natural resting states, design and obstacles optimization of passive orienting system for selected class of headed cylindrical parts, tuning the system, measurement and efficiency estimation of configured orienting system, estimating of mean feeding capacity.
LAB 3: Vision systems for part feeding - demonstration of vision system configuration and its use in part feeding, image analysis and identification of paths contours and its locations, identification of system performances and optimization.

Project covers following topics: 1. Assembly design and product design for assembly (DFA), 2. Parts presenting systems - orientation, separation and positioning task, 3. Working heads for part mating, part joining and other assembly operations, and 4. Transfer systems - assembly conveying, manipulation operations, line balancing and control.

prerequisite

Fundamental knowledge on Manufacturing and Production Systems, Factory Automation, Robotics, Control Engineering

learning resources

[2] Handouts /In Serbian/;
[3] Instructions for laboratory report writing /In Serbian/;
[4] Instructions and project example /In Serbian/;
[5] Instructions for handling the laboratory equipment /In Serbian/.
[6] Robotic cell equipped with sensory and acquisition system for demonstration of compliant part mating and RCC working principle;
[7] Experimental system based on linear vibratory conveyor for demonstration and students training in design of passive part presenting systems;
[8] Robotic welding system for demonstration of assembly joining operations based on welding and similar processes;
[9] Vision system for demonstration and students training in designing of flexible robotic part presentation systems;

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 6
laboratory exercises: 6
calculation tasks: 0
seminar works: 0
project design: 16
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 2
colloquium, with assessment: 0
test, with assessment: 6
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 25
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 15
final exam: 40
requirements to take the exam (number of points): 30

references

Combustion and sustainable development M

ID: MSc-1145
responsible/holder professor: Milivojević M. Aleksandar

level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written

goals

In the light of the fact that currently over 90% of world energy demand is produced by combustion processes, and that in the coming decades is expected that combustion will be the predominant technology for energy production, with a share of over 65%, this course is designed, keeping in mind that the main goal is to prepare students to work in the area of sustainable development and energy, to provide better understanding, accept the findings and enable students to competently participate in solving the problems of sustainable development.

learning outcomes

After successful completion of this course, students should be able to:
- analyze the challenges posed by the new scenario of the problem of energy and sustainable development,
- master the obtained knowledge to an extent that would allow them to apply combustion technology in both existing and future energy systems and technologies,
- apply the acquired knowledge in this field in the industry and energy sectors,
- work in research and development organizations.

theoretical teaching

The problem of energy. Energy sources.
Fossil fuels, renewable energy sources, industrial and municipal waste.
Environmental aspects - pollution of air, water and land.
Basics of the combustion process.
Material and energy balances.
Specifics of burning different types of fuel.
The impact on the environment.
The concept of sustainable development.
Complex systems.
Sustainable development in terms of the developed countries.
Specifics for developing countries.
Energy processes and devices based on combustion.
New technologies.

practical teaching

Practical training shall include practical exercises, laboratory exercises, computational tasks and seminars.

Within auditory exercises will be done more examples of material and energy balance of the
combustion process and pollutants, as well as the explanation of the principle of measuring emissions of combustion products. Laboratory classes will include measurements of emissions of polluting components from the combustion process. In the framework of the computational task, students will do an individual task in connection with the material and energy balance of a combustion fuel. Seminar will cover the analysis of the introduction of alternative energy sources, more favorable from the standpoint of sustainable development in a particular energy device or process.

**prerequisite**

None.

**learning resources**

Handouts.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 5
calculation tasks: 5
seminar works: 5
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 3
check and assessment of lab reports: 3
check and assessment of seminar works: 4
check and assessment of projects: 0
colloquium, with assessment: 2
test, with assessment: 3
final exam: 0

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 10
calculation tasks: 0
seminar works: 20
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references

A. Milivojevic, Subject handouts
Principles of Combustion (Принципи сагоревања), Kenneth K. Kuo, BARNES & NOBLE
Combustion M

ID: MSc-0971

responsible/holder professor: Stojiljković D. Dragoslava

teaching professor/s: Jovanović V. Vladimir, Manić G. Nebojša, Stojiljković D. Drageslava

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: oral

parent department: engineering materials and welding, tribology, fuels and combustion

semester.position: 2.4

goals


Environmental aspects of combustion.

learning outcomes

Mastering the techniques of calculation of material and energy balance of the combustion process. Mastering the techniques of flame investigation. Acquiring knowledge on the control of the combustion efficiency. Acquiring knowledge about the impact of combustion products on the environment.

theoretical teaching


practical teaching

Chemical kinetics, chemical equilibrium problem solving and speed of chemical reactions in combustion. Dissociation products of combustion, the calculation of the amount and composition of the products of combustion and combustion temperature. Incomplete combustion, determination of the amount and composition of the products of combustion and combustion temperature. Length of laminar flames, influential properties, experimental determination. The boundaries of stable combustion, the definition and experimental determination. Ignition limits (concentrations). Flame front propagation speed.

prerequisite

No special requirements.

learning resources

399

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 8
laboratory exercises: 20
calculation tasks: 2
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 2
check and assessment of lab reports: 3
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 5
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 40
laboratory exercises: 10
calculation tasks: 5
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

**references**
Distributed Systems in Mechanical Engineering

ID: MSc-0522
responsible/holder professor: Mitrović B. Časlav

Teaching professor/s: Bengin Č. Aleksandar, Vorotović S. Goran, Mitrović B. Časlav

Level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6

Final exam: project design
Parent department: information technologies
Semester.position: 2.4

Goals

• Introduction to the paradigm of distributing data
• Knowledge of basic protocols for the transfer and sharing of distributed data.
• Designing local area networks based on different technologies
• Introduction to multiprocessor distributed systems in the automotive and aircraft industry
• Introduction to algorithms that are typical of multi-processor distributed systems

Learning outcomes

Стечено знање омогућава студенту:

• to recognize the conditions for the formation of local area networks
• to allocate names to resources on the net
• to control and manage assigned resources
• to understand the multi-processor and redistribution of data among them

Theoretical teaching

Local and remote computer network as a weak coupled systems. The concept of server and service provider
Indoor network systems. Assignment of rights and names in the closed network systems.
Application of these systems in the automotive and aircraft industry.
Local area network-LAN
Recommendations in the formation of IEEE local computer networks and their links.
IP protocol.
Wireless local area networks. Use of multi-radio waves in the small computer networks. User control in a wireless network
Multiprocessor systems. Algorithms for controlling the resources used in operating systems for multiprocessor hardware systems.
The case studies specific to the automotive industry. Case studies characteristic of the civil and military aerospace industry.

Practical teaching

It consists of auditory, laboratory exercises that accompany the course. We should particularly look at case studies in the auto industry and the aviation industry.

Prerequisite
Required: Basic computer culture based on the use of a PC, regardless of operating system.

learning resources

- The necessary software for this case under the GNU license - free of charge.
- To run the necessary software is enough to have the simplest PC.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 6
laboratory exercises: 16
calculation tasks: 0
seminar works: 7
project design: 8
consultations: 0
discussion and workshop: 3
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 2
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 3
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 15
laboratory exercises: 5
calculation tasks: 0
seminar works: 15
project design: 30
final exam: 30
requirements to take the exam (number of points): 35

references
Electronics

ID: MSc-1073
responsible/holder professor: Stojić M. Tomislav
teaching professor/s: Lukić M. Petar, Stojić M. Tomislav
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: physics and electrical engineering
semester.position: 2.4

goals

Introduction to the basic principles and laws of analog and digital electronics and developing competencies for further adoption of academic knowledge and skills in scientific, professional and applied fields of mechanical engineering that rely on electronics. Getting to know basic electronics components and circuits and introduction to the methods for their analysis, simulation and design.

learning outcomes

Student should be able to:

1. theoretical and mathematical adequately describe and interconnect basic concepts, laws, relations and processes that are engaged in physics of semiconductors, analog and digital electronics;

2. mathematical adequately express and interconnect the various electrical and other physical quantities that are encountered in electronics, through a range of other given quantities and thus demonstrates the logical and mathematical skills for basic engineering modeling of the phenomena and processes in electronics;

3. apply acquired knowledge of concepts, laws, relations and processes that govern the physical electronics and electronic circuits, in analyzing, mathematical formulating and solving basic and fundamental engineering problems in electronics;

4. theoretically and mathematically describe and relate the basic concepts of the theory of electronic measurement;

5. apply theoretical knowledge in the field of electronics and analysis of electronic circuits in basic electronic measurements in the laboratory and simulation on the computer;

Examination of outcomes referred to in points 1), 2) and 4) is carried out through the questions on tests, colloquiums and final exam, or checking of student responses to questions.
Check of the outcome of item 3) is carried out through computational tasks on tests, colloquiums and written part of the final exam, which is also the outcome of the additional checks referred to in point 2).
The outcome of point 5) is checked by an independent laboratory exercises of the students.

theoretical teaching
Definition of electronics and a brief historical overview of the development. Signals and Systems; The use of computers in the analysis, simulation and design of electronic circuits; Fundamentals of semiconductor physics (structure of crystals, pure and impurity semiconductors, electrical properties, transport processes); PN-junction (forming, without polarization and with direct and inverse polarization, capacitance of space charge region, diffusion capacitance, voltage breakdown); Semiconductor diode (static characteristics, models for small and for large signals, temperature effects, analysis of diode circuits, switching mode, special diodes - Zener diode, Schottky, LED, tunnel, PIN photodiode, application); Bipolar junction transistors (working principle, the distribution of currents, amplifying ability, model for large signals, static characteristics, polarization, equivalent circuit for small signals, model for high frequencies, operating modes, constraints, breakthrough, temperature effects, switching mode); Field effect transistors JFET-MOSFET (working principle, static characteristics, polarization, equivalent circuit for small signals, model for high-frequency, switching mode); Amplifiers (transfer function, equivalent circuit, frequency response, feedback). Operational amplifiers (characteristics, basic circuits and applications in linear and nonlinear signal processing); Harmonic oscillators (analysis, types, stabilization of amplitude and frequency of oscillation). Pulse oscillators; Power amplifiers (with transistors, transformers and complementary pair); The multi-layered silicon components (thyristor, diac and triac). Elements of digital electronics (numerical systems, Boolean algebra, logic gates, basic combinational and sequential networks, bistable circuits); A / D and D / A converters.

practical teaching

For auditory exercises are being selected numerical examples that follow the curriculum of lectures. There will also be four labs: 1) Basic application of diodes (rectifiers, limiters and voltage level shifters); 2) Single-stage power amplifier with bipolar transistor, in conjunction with common emitter (adjusting the quiet working point and recording of frequency characteristics); 3) Selected circuits with operational amplifiers for linear and nonlinear signal processing; 4) Logical circuits: selected combinational networks and counters. In both types of exercises is planned intensive use of software packages: LT Spice, Logisim and student versions of Multisim.

prerequisite

Defined by curriculum program of study. This subject can listen only students who had no electronics at the undergraduate level.

learning resources

5. M. Popovic: Electronics fundamentals, script, ЕТФ Београдa, 2006, /In Serbian/;
6. Printed excerpts from lectures ("handouts")/In Serbian/;
7. Software, LT Spice, Logisim and student versions of Multisim.

number of hours

404
total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 20
laboratory exercises: 8
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
calculation tasks: 0
colloquium, with assessment: 9
test, with assessment: 3
final exam: 3

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 60
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

**references**

Environmental Protection in Thermal Power Engineering

ID: MSc-0912

responsible/holder professor: Stevanović D. Vladimir

Teaching professor/s: Milivojević S. Sanja, Stevanović D. Vladimir

Level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

Final exam: oral

Parent department: thermal power engineering

Semester.position: 2.4

Goals

The aims is acquiring academic knowledge about sources and characteristics of hazardous gases emission and other harmful influences in all phases of thermal power plants exploitation, about the environmental influence of harmful emission, about possible technical solutions, processes and equipment for the emission reduction, harmful waste storage, as well as about the importance of these activities for economic and social development.

Learning outcomes

The students master their knowledge and skills in the field of environmental protection from the harmful emissions from the thermal power plants. Besides being acquainted with the sources of harmful emissions and methods and equipment for their reduction and storage, the students are trained to quantify harmful emissions and to estimate the technical, ecological and economical effects of current methods and measures for environmental protection.

Theoretical teaching

The influence of thermal power plants on environment and harmful emissions, maximum allowed emissions, regulatory laws related to harmful emissions, international activities towards environment protection and reduction of green house gases emissions, technologies and plants for emission reductions from thermal power plants, such as dust removal from flue gases, flue gases desulphurization, NOx removal, carbon dioxide capture and storage. The influence of atmospheric conditions on emissions propagation and harmful matters dispersion, storage of solid combustion products, heat load to the environment from thermal power plants, current developments of thermal power plants efficiencies from the standpoint of emissions reductions.

Practical teaching

Prediction of the harmful emissions during the operation of the thermal power plants, evaluation of conceptual design of plants for the harmful emissions reduction in accordance with the law regulation, ecological and economical effects of methods for emission reduction, criteria for chimney selection, analyses of wet and dry methods for flue gases desulfurization, analyses of plant accidental conditions on environmental pollution.

Prerequisite

Passed exam in Thermodynamics.
learning resources

Course handouts. Instructions for seminar work. Vendors’ technical documentation of plants for environmental protection at thermal power plants.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 15
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 4
check and assessment of projects: 0
colloquium, with assessment: 8
test, with assessment: 0
final exam: 3

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 45
laboratory exercises: 0
calculation tasks: 0
seminar works: 20
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references
High Speed Aerodynamics

**ID:** MSc-0950  
**responsible/holder professor:** Kostić A. Ivan  
**teaching professor/s:** Bengin Č. Aleksandar, Kostić A. Ivan, Kostić P. Olivera, Mitrović B. Časlav  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** aerospace engineering  
**semester.position:** 2.4

**goals**

The aim of this course is to introduce students to basic concepts of high speed aerodynamics. Emphasis is given to transonic and supersonic flow problems. External flows (supersonic airfoils, wings and complete aircraft lifting configurations) and internal flows (supersonic intakes, nozzles and diffusers).

**learning outcomes**

Upon completion and passing the course the student should be capable of understanding the basic concepts and problems in the field of aerodynamics at transonic and supersonic speeds. It is expected that the student knows how to apply the acquired knowledge in this field to solve practical engineering problems.

**theoretical teaching**

The theoretical part of the course covers the following topics: Classification of flow and flow model (Navier-Stokes equations, the Euler, the potential of small disturbances, Prandtl-Glauert and Laplace). Singularities and discontinuities in the flow field. The method of characteristics and conical flow field. Airfoil in transonic and supersonic field (linear airfoil theory and the theory of higher order). Wing in supersonic flow (influence of tips, sweep, delta wing, supersonic and subsonic leading edge). Computational analysis of complete aircraft lifting configurations in transonic and supersonic flow fields. Intakes, nozzles and diffusers.

**practical teaching**

Practical part of course demonstrates numerical examples in all areas. Practical work of students is accomplished through a virtual classroom, available 24 hours (program MOODLE). In the workshop students have access to the professor's lectures (handouts) and tests for practice. Practical training includes preparation of three projects. Each student works individually, and student qualifies for the final exam after completing at least two of the three projects.

**prerequisite**

Attended course in Applied Aerodynamics, or a course in fluid mechanics which provides satisfactory background knowledge (with professor’s approval).

**learning resources**
The students have access to the virtual classroom on the Internet. At the first lecture students are enrolled and trained for work (Moodle software). In the workshops students have access to the lectures and exercises, guidelines for project preparation, internet resources, etc.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 5
seminar works: 0
project design: 5
consultations: 10
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 5
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 30
requirements to take the exam (number of points): 25

**references**

Mechanical engineering measurements and sensors

ID: MSc-0926

responsible/holder professor: Ilić B. Dejan

Teaching professor/s: Ilić B. Dejan, Ilić T. Jelena

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: written

parent department: hydropower engineering

semester.position: 2.4

goals

Research, development and practice in science and engineering cannot be imagined without the experimental methods that are combined in the field of measurement techniques. The aim of this course is to provide basic and specific knowledge in the field of experimental methods necessary for mechanical engineers, with special reference to flow measurement techniques. The subject involves measuring the nonelectrical quantities in mechanical engineering and their transformation into electrical quantities using sensors. Through specific measurements in the laboratory, students are introduced to the field of practical experimental methods.

learning outcomes

On successful completion of this course, students should be able to:
1. Apply theoretical knowledge in practical measurements of some quantities in mechanical engineering,
2. Describe measurements methods of some quantities (velocity, flow, pressure and fluid temperature) and specify classical and contemporary measuring techniques,
3. Process and present the measurement results,
4. Calculate the measurement uncertainty,
5. Explain the calibration of velocity, pressure and flow measuring devices,
6. Describe the types and characteristics of sensors.

theoretical teaching

Theoretical lecturing is realized through the following core learning areas:
- Error of direct and indirect measurements. Measurement uncertainty.
- Theoretical basis of measurement non-compressible and compressible fluid flow.
- Measurement of pressure and velocity of fluid flow.
- Measuring velocity as vector quantities.
- Temperature measurements.
- Measurement of fluid flow.
- Measurement of humidity. Measuring the frequency of rotation, force, torque and power drive and driven machinery.
- Sensors (types, properties, characteristics, materials). Resistive, capacitive, inductive and generator sensors.

practical teaching

Auditory exercises:
- Errors of direct and indirect measurements of measurement quantities. Measurement uncertainty.
- Measurement of pressure and velocity of fluid flow. Pressure gauges and anemometers.
- Measuring velocity as vector quantities.
- Measuring compressible flow parameters.
- Sensors (types, characteristics, dynamic characteristics, materials).
- Resistant, capacitive, inductive and generator sensors.

Laboratory exercises:
- Determining the pressure distribution around the contour of the cylindrical probe,
- Cylindrical probes calibration,
- Measurements of temperature sensors.

prerequisite

Desirable: Thermodynamics, Fluid Mechanics, Physics and measurements.

learning resources

[2] Hand-outs from the written lectures,
[4] The experimental installation for velocity and pressure probe calibration, available in the laboratory of the Department,
[5] The experimental installation for calibration of the pressure devices, available in the laboratory of the Department,

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 15
calculation tasks: 15
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 5
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 40
laboratory exercises: 22
calculation tasks: 3
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**

Mechanics of robots

**ID:** MSc-0007  
**responsible/holder professor:** Lazarević P. Mihailo  
**teaching professor/s:** Lazarević P. Mihailo  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** mechanics  
**semester.position:** 2.4

**goals**

Introduce students to basic concepts of kinematics and dynamics of robotic systems. It is possible to solve direct and inverse kinematics and dynamics of the robot system (RS) using modern theory based on Rodriguez transformation matrix as well as the theory of finite rotations. Determination (simulation) models of RS - i.e. differential equations of motion of the RS, which are important in practical problems of the RS. Practical simulations RS using Cyberbotics Webots software package and students work with laboratory robot NEUROARM.

**learning outcomes**

- Determine the number of degrees of freedom of robotic system (RS)
- Define the matrix of transformation, in the case of (Euler angles, Rezal angles, Hamilton-Rodrigues parameters, ...)
- Forming expressions to determine the basic kinematic characteristics RS using Rodrigues approach: characteristic position vectors of RS, speed and acceleration of the center of inertia of the robot segments (RSE), angular velocity and angular acceleration RSE, speed and acceleration of the robotic gripper
- Forming a kinematic model RS and solve direct and inverse kinematics task of RS
- Analyze singular cases in solving the task of kinematics RS
- Formed terms of linear momentum, angular momentum and kinetic energy of arbitrary segment RS
- Determine the kinetic energy of the whole RS, the basic metric tensor RS, the corresponding generalized forces, Christoffel symbols of the first kind for given RS
- Forming the differential equations of motion using the RS covariant form of Lagrange equations of the second kind and solve other types of direct and inverse task of dynamics
- Numerical simulate the previously formed kinematic / dynamic models using programming environment (MATLAB, Mathematica, etc.)
- Forming the differential equations of motion RS for the case of RS: which is given in the form of a kinematic chain with branching , RS given in the form of a closed kinematic chain.
- Set additional constraint equations in the case of constrained robotic gripper movements
- Distinguish non-redundant and redundant RS and determine the degree of redundancy RS
- Distinguish the basic concepts of control of RS

**theoretical teaching**

Basic concepts, definition of robot system (RS). Orthogonal transformation of coordinates. Rodriguez formula and the transformation matrix (MT), arbitrary and reference configuration of RS. Complex MT of coordinates. Position vectors that define the configuration of the RS, internal and external coordinates of RS. Velocity and acceleration of the center of inertia of an arbitrary robot segment (RSE). Angular velocity and angular
acceleration of an arbitrary RSE. Velocity of gripper tip of RS. Direct and inverse kinematics of robot task—as well as singular cases. Constraints of RS. Momentum, angular momentum, kinetic energy of arbitrary robot segment of RS. Kinetic energy and the metric tensor of RS. Generalized forces and the principle of ideality RS—different cases. Differential equations (DIFE) of motion of RS. (DIFE) of motion of the RS in covariant form. Other methods of forming (DIFE) of motion of RS. DIFE of motion of RS given in the form of kinematic chain with the structure of topological three; DIFE of motion of RS given in the form of closed-kinematic chain. Additional equations of contraints. Constrained motion of robotic gripper. Equations of motion of RS with Lagrange multipliers. Redundant RS. Basic concepts of control RS.

**practical teaching**

Examples of determining the number of degrees of motion of the RS; Calculation the transformation matrix (MT)—in case of Euler angles, and Hamilton-Rodriguez parameters; Determination of kinematic characteristics of the robot segment (RSE): angular velocity and angular acceleration RSE, velocity and acceleration of the observed point—RSE cases of Rezales and Euler angles. Application of Rodriguez transformation matrix, determine position vectors which define the configuration of the RS—in MATLAB environment. Kinematic characteristics of the i-th robot segment. Solving the direct and inverse kinematic task of RS. Determination of (planar) inertia tensor RSE, RS. Obtaining momentum and angular momentum, kinetic energy, the coefficient of the metric tensor RS, generalized forces, Christoffel symbols of the first kind. Solving the direct and inverse dynamics task of the RS. Examples of DIFE of RS simulation in MATLAB-GUI, MATHEMATICA environment, an example of a redundant RS. An example of simulation RS using Cyberbotics Webots package. Example of control of the RS-laboratory robot NeuroArm with 7 degrees of freedom in the MATLAB environment.

**prerequisite**

desirable courses: Mechanics 1, Mechanics 2 Mechanics 3,

**learning resources**

1. Čović M. V. Lazarević, Mechanics of Robot, MF Belgrade, 2009. (Book)
2. Lazarević M. Exercises in mechanics of robot, MF Belgrade, 2006. (ZZD)
5. Written abstracts from the lectures (Handouts)
6. Cyberbotics Webots - software package
8. MATLAB, MATHEMATICA—mathematics software packages

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**
auditory exercises: 10
laboratory exercises: 6
calculation tasks: 5
seminar works: 0
project design: 6
consultations: 3
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 4
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 40
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 40
requirements to take the exam (number of points): 30

**references**

Risk management in Terotechnology

ID: MSc-0513
responsible/holder professor: Spasojević-Brkić K. Vesna
teaching professor/s: Spasojević-Brkić K. Vesna
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: industrial engineering
semester.position: 2.4

goals

The aim of this course is to acquire the necessary knowledge and practical skills that will enable students to apply maintenance systems based on risk management, due to knowledge in the identification, analysis, risk assessment and decision-making on the basis of these facts.

learning outcomes

Student after completing the course is able to: a) recognize /describe core systems, methods and strategies of terotechnology procedures b) applies terotechnology method based on risk, c) applies models RIMAP (Risk Inspection Maintenance Procedures) d) applies RCM models (Models for reliability based maintenance) in practice, and e) elect / propose appropriate solutions for the mitigation of risk. Upon successful completion of this course, students are able to choose the appropriate method, collect the data source required for the implementation of certain methods of risk management, conduct methodological procedure, conduct specific methods of processing results, critically consider and make decisions on the mitigation of risk depending on the results.

Theoretical teaching


Practical teaching

Collection and systematization of data collected in companies. Evaluation of data on individual risks. Preliminary risk matrix. Calculation of individual risk. Risk matrix. Preliminary evaluation of the possible scenarios of origin effects. Risk tools application. Detailed analysis of one or more of the selected scenarios, including probability analysis to achieve them. Detailed technical analysis of possible consequences of different scenarios. The overall analysis of possible consequences and analysis in terms of insurance and reinsurance.

prerequisite
Enrolled semester.

**learning resources**

4. Handout

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 25

**active teaching (practical)**

auditory exercises: 3
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 31
consultations: 1
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 2
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 3
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 10
laboratory exercises: 0
calculation tasks: 20
seminar works: 0
project design: 25
final exam: 35
requirements to take the exam (number of points): 30

**references**
Sensors and Computer Based Measurements

ID: MSc-0959
responsible/holder professor: Miljić L. Nenad
teaching professor/s: Miljić L. Nenad
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: project design
parent department: internal combustion engines
semester.position: 2.4

goals

The aim of the course is to provide comprehensive insight into the sensors and digital acquisition systems (DAQ), measurement systems and, mainly, their usage in the field of systems testing in the area of Mechanical Engineering; To introduce students the world of virtual instrumentation and graphical programming environment (LabVIEW) which is dedicated to development of DAQ applications. To gain experience on functioning and using DAQ systems through numerous, real world, examples. To get closer acquaintance with the sensors, and digital acquisition software & hardware, in general, and methods of DACQ software developing and testing.

learning outcomes

Ability to integrate sensors and DAQ hardware in measurement chains in order to fulfill specific requirements in the field of mechanical engineering system testing & measurements. Ability to build and test software application (LabVIEW virtual instruments) for measurement and automation of various mechanical engineering systems. Practical knowledge in computer based measurements of fundamental engineering data. Supplied basic knowledge and practice in LabView environment sufficient to apply for a test and getting a degree of certified CLAD programmer.

theoretical teaching

Measurement Techniques; Measurement of Non-Electrical Quantities (Sensors and Sensor Systems, Displacement and Angles, Speed, Acceleration, Force, Torque, Pressure, and Mass, Temperature, Flows, Signal Conditioning); Digital Measurement Techniques (Discretisation of Amplitude and Time, Sampling Theorem, Quantization, A/D and D/A Converters, Measurement of Frequency, Counters); Architecture and basic principles of data acquisitions systems (DAQS); Measurement Errors and Statistics; Static and Dynamic Behavior of Sensors.

practical teaching

Introduction to the Virtual Instrumentation (VI) and LabVIEW development environment; Data flow in VI; Troubleshooting and Debugging Vis; Implementing a VI; File I/O Techniques; Common Design Techniques and Patterns; Managing Hardware resources; Synchronization Techniques; Event Programming; Error Handling; Controlling the User Interface; Improving an Existing VI; Practice labs with various sensors and measurement chains building tasks. Student Project: Building a DAQ with given requirements (complied with the Student's module syllabus);

*) National Instruments (NI) Labview courses “Core 1” & “Core 2” are incorporated in the
theoretical and practical teaching of this course. This course is in compliance with the “LabVIEW Academia” program and therefore offers students all benefits stated in LabVIEW Academia agreement.

**prerequisite**

No particular requirements for attending this course

**learning resources**

Handouts: N. Miljić, Computer Based Measurements & Virtual Instrumentation

DACQs: National Instruments USB 6008, MyDAQ, PXI, ...

Graphical Development Environment: National Instruments LabView 2010 with modules and toolkits (LVA package)

Auxiliary platforms: Demo board for simulation of analog and digital signals; Universal Amplifying / Conditioning board for various sensors; Driver board for DC and step motors.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 20

**active teaching (practical)**

auditory exercises: 20

laboratory exercises: 19

calculation tasks: 0

seminar works: 0

project design: 3

consultations: 0

discussion and workshop: 1

research: 0

**knowledge checks**

check and assessment of calculation tasks: 4

check and assessment of lab reports: 0

check and assessment of seminar works: 0

check and assessment of projects: 5

colloquium, with assessment: 0

test, with assessment: 3

final exam: 0

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0

test/colloquium: 45

laboratory exercises: 0

calculation tasks: 5

seminar works: 0

project design: 10
final exam: 40
requirements to take the exam (number of points): 42

references

Labview Core 1 & 2 Course Manual & Exercises, National Instruments
J. Hoffmann: „Taschenbuch der Messtechnik“, 4. Aufl., Hanser, 2004
Ship Equipment M

ID: MSc-0975  
responsible/holder professor: Simić P. Aleksandar  
teaching professor/s: Simić P. Aleksandar  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 2  
final exam: written  
parent department: naval systems  
semester.position: 2.4

goals

The aims of the course are to familiarize students with: 1) basic ship equipment, both with the one found on each ship and with a special one found on some types of ships; 2) essential characteristics of various ship types; 3) regulations concerning ship equipment; 4) the expected development of ship types and their equipment.

learning outcomes

Having successfully mastered the teaching contents of Ship equipment, the student should demonstrate fundamental knowledge about:
1) ship equipment;
2) various types of ships and their essential characteristics;
3) the expected development of ship equipment and ship types etc.

theoretical teaching

In brief, the course comprises the following teaching units:

1) Deck equipment (anchoring, mooring and steering device).
2) Cargo access equipment (for vertical and horizontal cargo handling), ship cranes. 3) Safety equipment (rescue, navigational).

The Ship equipment course gains in importance concerning the fact that ships differ in the first place in the installed equipment. The cost of ship is considerably affected by the installed equipment. Ship equipment, on the other hand, is not manufactured in the shipyards but is manly purchased from specialized manufacturers. That is, to some extent, the reason why the content of the course is mainly encyclopedic in its character.

practical teaching

The student is in the focus of practical teaching. Attention is directed to the application of knowledge, previously attained by theoretical teaching, and needed for common engineering practice. Emphasis is placed on classification societies’ rules related to ship equipment. World leading ship equipment manufacturers’ brochures and leaflets provide a source for students to get acquainted with technical characteristics and specificities of equipment installing, depending on the type of ship.

prerequisite

There are no prerequisites
learning resources

Lectures are available in electronic form
Various classification societies’ rules
Brochures of various equipment manufacturers
Internet resources

number of hours

total number of hours: 30

active teaching (theoretical)

lectures: 12

active teaching (practical)

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 1
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 45
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 50
requirements to take the exam (number of points): 20

references
Camac, brod, brodogradnja, Tehnicka enciklopedija, Jugoslovenski leksikografski zavod, Zagreb.
Ship systems M

ID: MSc-1016  
**responsible/holder professor:** Kalajdžić D. Milan  
**teaching professor/s:** Kalajdžić D. Milan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 4  
**final exam:** written+oral  
**parent department:** naval systems  
**semester.position:** 2.4

**goals**

To cover the basic knowledge of Marine Engineering connected to ship piping and pumping systems.

**learning outcomes**

Ability in basic design, calculations and analysis of ship piping and pumping systems: bilge, ballast, emergency, heeling, sanitary, tanker, firefighting systems, etc.

**theoretical teaching**

Ship piping systems: pressure diagram, piping characteristics, characteristics of marine pumps, joint operation of pumps and a piping, suction head problems. Piping armature. Types of marine pumps. Individual ship systems: Bilge system, emergency system, rescue system; Ballast system; Heeling and trim system; Sanitary systems: system of fresh and sea water, system of waste water. Drainage system. Tanker systems: cargo system, stripping system, tank ventilation, tank cleaning, cargo circulation, cargo heating system. MARPOL Regulations. Firefighting systems: fire detection, fire-fighting systems (water, inert gases, foam, halons).

**practical teaching**

Principle design and calculations of various ship piping and pumping systems. Practical examples of ship systems, illustrating the subjects lectured in theoretical syllabus.

**prerequisite**

Exams passed in Fluid mechanics B or M.

**learning resources**

[1] Extracts from lectures (handouts) /In Serbian/.
[2] Instructions for making tasks from ship systems /In Serbian/.

**number of hours**

total number of hours: 45

**active teaching (theoretical)**
lectures: 18

**active teaching (practical)**

auditory exercises: 18
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 50
requirements to take the exam (number of points): 10

**references**

R.L. Harrington: Marine Engineering, SNAME 1992
A. Rowen et al: Introduction to Practical Marine Engineering, SNAME 2005
Theory of Mechanical Vibrations

**ID:** MSc-0037  
**Responsible/Holder Professor:** Obradović M. Aleksandar  
**Teaching Professor(s):** Zorić D. Nemanja, Jeremić M. Olivera, Lazarević P. Mihailo, Mitrović S. Zoran, Mladenović S. Nikola, Obradović M. Aleksandar, Radulović D. Radoslav, Stokić M. Zoran, Trišović R. Nataša  
**Level of Studies:** M.Sc. (graduate) academic studies  
**ECTS Credits:** 6  
**Final Exam:** oral  
**Parent Department:** mechanics  
**Semester Position:** 2.4

**Goals**

It is necessary to enable the students to independently form and solve linear differential equations of motion of mechanical models of real objects oscillatory moving in different areas of mechanical engineering.

**Learning Outcomes**

Upon successful completion of this course, students will be able to:

- Determine equilibrium position of conservative mechanical system with finite number of degrees of freedom.
- Form differential equations of motions of small mechanical vibrations of a mechanical system about the equilibrium position in matrix form (determine generalized mass, stiffness and damping matrices, as well as vector of generalized forces transformed on Fourier series).
- Analyze free and forced, as well as damped and undamped linear mechanical vibrations, in a clear observation of phenomena in linear mechanical vibration as well as resonance, beating and the dynamic absorber).
- Calculate (analytical and numerical) quantities which characterize vibration processes: natural frequencies, amplitudes, phase angles, logarithmic decrements and modal matrix.
- Determine equations of motion in analytical form using software (Matlab...) for systems with large number of degrees of freedom.
- Describe free undamped mechanical vibrations of elastic bodies with 1-D mass distribution with appropriate partial differential equations, for cases of longitudinal, torsion and lateral vibrations.

- Numerically solve characteristic equation for various cases of boundary conditions and determine angular frequencies. Determine analytical solutions of appropriate partial differential equations in simpler cases initial and boundary conditions.

**Theoretical Teaching**

prismatic bodies. Torsional vibration of the shaft with circular cross section. Lateral vibration of prismatic bodies.

**practical teaching**


**prerequisite**

None

**learning resources**

Vuković, J., Obradović, A., Linear vibrations theory of mechanical systems, Mašinski fakultet, Beograd, 2007.,

handouts


MATLAB software

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 24
laboratory exercises: 6
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**
check and assessment of calculation tasks: 0
check and assessment of lab reports: 4
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 45
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

references

Transport solid particles by pipe

ID: MSc-0562
responsible/holder professor: Crnojević Đ. Cvetko
teaching professor/s: Crnojević Đ. Cvetko
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: fluid mechanics
semester.position: 2.4

goals

learning outcomes

theoretical teaching

practical teaching

prerequisite

learning resources

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 25
laboratory exercises: 3
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 2
check and assessment of lab reports: 4
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 4

assessment of knowledge (maximum number of points - 100)
feedback during course study: 10

test/colloquium: 35

laboratory exercises: 5

calculation tasks: 0

seminar works: 0

project design: 0

final exam: 50

requirements to take the exam (number of points): 20

references
Turbomachinery

**ID:** MSc-1001  
**responsible/holder professor:** Čantrak S. Đorđe  
**teaching professor/s:** Čantrak S. Đorđe  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** hydropower engineering  
**semester.position:** 2.4

**goals**

Theoretical background in turbomachinery basic principles. Practical, engineering knowledge in turbomachinery and their applications, with focus on hydraulic turbomachinery.

**learning outcomes**

Upon successful completion of this course, students should be able to:
1. identify and describe the various types and constructions of turbomachinery, as well as the principles of their work,
2. calculate and apply dimensionless parameters (characteristic coefficients),
3. determine the duty point of the hydraulic turbomachine and system,
4. select the appropriate pump or fan, as well as the most energy efficient way of their regulation,
5. calculate the pump duty point in terms of cavitation,
6. calculate the thermodynamic and energy parameters of the turbocompressor,
7. plan the fan testing according to the international standard.

**theoretical teaching**


**practical teaching**

   Dimensionless quantities determination (pumps, fans and turbocompressors).  
2. Project - Design of the radial fan impeller:  
   Determination of the optimal dimensionless quantities and main geometry characteristics of the radial turbomachine (outlet and inlet diameters, angles and etc.). Determination of the meridional section and its check.  
3. Laboratory exercises:
3.1. Demonstration in the Laboratory for hydraulic machinery:
- pumps, hydraulic turbine, fans and turbocompressors - constructions
- systems with turbomachines.
3.2. Exercises: Determination of the fan energy characteristics.

prerequisite

Passed exams: Fluid Mechanics B and Thermodynamics B.

learning resources

1. Books listed in literature and reference list available for students.
2. Lectures and exercises outlines.
3. Instructions for design of the multistage axial turbocompressor and centrifugal pump.
4. Laboratory with test rigs and measurement equipment for hydraulic turbomachinery -
pumps, turbines, fans, as well turboblowers and turbocompressors.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 21
laboratory exercises: 3
calculation tasks: 3
seminar works: 0
project design: 0
consultations: 3
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 5
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 1
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 60
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references

Obradović N. (1962): Basic theory of turbomachinery, Građevinska knjiga, Belgrade (in Serbian)
Benišek M. (1998): Hydraulic turbines, Faculty of Mechanical Engineering, Belgrade (in Serbian)
Wind Turbines 2

**ID:** MSc-1130

**responsible/holder professor:** Svorcan M. Jelena

**teaching professor/s:** Peković M. Ognjen, Svorcan M. Jelena, Simonović M. Aleksandar

**level of studies:** M.Sc. (graduate) academic studies

**ECTS credits:** 6

**final exam:** oral

**parent department:** aerospace engineering

**semester.position:** 2.4

**goals**

The course provides an overview of key aspects in wind energy engineering as well as design principles of wind turbines. Throughout the course the student will be acquainted in detail with the most fundamental disciplines of wind energy research such as: wind measurements and resource assessment, possible wind turbine designs and their modeling, aerodynamics, structural mechanics, wind turbine manufacturing technology and materials, electrical systems etc, which will be realized through the use of different, simpler analytical, empirical and numerical methods.

**learning outcomes**

The student will gain a rational understanding of wind energy engineering and different wind turbine concepts and design methods.

Through hands-on exercises, the student will learn to perform wind energy calculations based on simple models.

Working with the different course disciplines (applied mathematics, programming, CFD, structural mechanics, optimization, manufacturing technologies) will enable the student to identify the most interesting and/or relevant aspects of wind energy engineering to be pursued in his/her future studies or professional career or applied on similar structures (propellers, helicopter rotors).

**theoretical teaching**

- Introduction to wind energy
- Wind resources (wind speed variability); Test and measurements
- Wind turbine technology (historical development, different wind turbine designs and components)
- Aerodynamics (fundamental principles and simple computational models)
- Materials; Structural mechanics (blade mass and structure, loads acting on the blade, stress-strain analysis)
- Wind turbine blade optimization
- Mechanical drive train and nacelle; Electrical system (power transmission, integration of the very variable power production with the electrical grid, rotor speed control)
- Blade manufacturing
- Additional topics: Support structure design, Vibration problems, Offshore wind energy engineering, Wind turbine aeroelasticity, Blade testing, Wind turbine economics

**practical teaching**

- Introduction to variable wind speed profiles modeling; Measuring equipment
- CAD of basic wind turbine components (including various types of wind turbines)
- Blade design (computation of fluid flow around the blade)
- Thrust and power calculations of wind turbines (by writing and using numerical codes)
- Overview and definition of blade structure and materials
- Wind turbine blade stress-strain analysis
- Wind turbine blade optimization
- Manufacturing blade model or segment and/or blade mould
- Blade testing (static and/or dynamic)

**prerequisite**

There are no mandatory conditions/prerequisites for course attendance.

**learning resources**

Classroom, projector, computer (laptop), computational software tools, CNC mill, 3D printer, measuring equipment.

**number of hours**

Total number of hours: 75

**active teaching (theoretical)**

Lectures: 30

**active teaching (practical)**

Auditory exercises: 10
Laboratory exercises: 12
Calculation tasks: 5
Seminar works: 8
Project design: 0
Consultations: 0
Discussion and workshop: 0
Research: 0

**knowledge checks**

Check and assessment of calculation tasks: 0
Check and assessment of lab reports: 2
Check and assessment of seminar works: 2
Check and assessment of projects: 0
Colloquium, with assessment: 2
Test, with assessment: 0
Final exam: 4

**assessment of knowledge (maximum number of points - 100)**

Feedback during course study: 5
Test/colloquium: 15
Laboratory exercises: 15
Calculation tasks: 15
Seminar works: 15
Project design: 0
final exam: 35
requirements to take the exam (number of points): 30

references

Pešić S. Wind energy - Aerodynamics of wind energy systems with horizontal axis of rotor (in Serbian), Faculty of Mechanical Engineering, Belgrade, 1994.
Additional materials (handouts, exercises and instructions for their solution)
Basics of Composite Materials Mechanics

ID: MSc-0721
responsible/holder professor: Balač M. Igor
teaching professor/s: Balač M. Igor, Grbović M. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: strength of structures
semester.position: 2.5

goals

Main objective of the course is to teach students the fundamental principles of the mechanics of composite materials. This theory is further applied to design and analyze unidirectional and multidirectional fiber composite laminates. Within the course the basic issues associated with the design of composite materials will be studied as well. A special attention will be devoted to the practical stress and strain analysis of mechanical components made out of composite materials. Issues connected to the characterization of mechanical properties of composite materials will be tackled as well.

learning outcomes

1. Within the course students will learn various methods of the assessment of elastic constants entering into constitutive equations which describe mechanical behavior of composite materials. Problems of determination of macro behavior of composite materials starting from known properties of components entering into it will be tackled as well. The course will cover also the study of different failure criteria for various types of composite materials.
2. Students will learn how to perform stress – strain analysis of laminate composite materials.
3. The course will devote some attention to the influence of the environmental conditions (e.g. temperature and humidity) to the variation of mechanical properties of composite materials. This will be studied with a special focus on unidirectional and multidirectional composite laminates.
4. By completing this course students will become familiar with basic concepts of mechanics of composite materials. A special attention will be devoted to the practical procedures of stress analysis of mechanical components made out of composite materials, with numerical implementation of the most frequently used techniques.

theoretical teaching

1. Introduction to composite materials: Basic concepts. Classification, main characteristics and the most frequent applications of composite materials in modern engineering.
5. Stress – strain and failure analysis of multidirectional composite materials. Strength of
lamina under tension and shear. Inter-laminar stresses. Laminate strength analysis. First ply failure.

**practical teaching**

1. Analytical examples of the assessment of macro mechanical properties of the composite materials.
2. Examples of the Hooke’s law theory applied to the two dimensional unidirectional laminates. Determining of the stiffness matrix for the composite material.
4. Numerical examples of determination of the ultimate strength using diverse failure criteria. Practical applications of failure theory to the ultimate strength calculations of mechanical components made out of composite materials.
5. Examples of numerical implementations of diverse modeling techniques of composite materials into the available codes. Comparison of numerical and analytical predictions of composite material component behavior.

**prerequisite**

Taken exams:
Strength of materials,
The base of strength of constructions.

**learning resources**

The whole course material is well covered by hand-outs written by the lecturers of the course. Every attendee of the course will be provided his/hers own copy of the hand-outs. Apart of this, all the below mentioned books can be borrowed from the lecturers during the course or ordered on some relevant websites.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 35

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 15
seminar works: 10
project design: 0
consultations: 10
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 1
check and assessment of lab reports: 0
check and assessment of seminar works: 1  
colloquium, with assessment: 1  
test, with assessment: 1  
final exam: 1

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5  
test/colloquium: 40  
laboratory exercises: 0  
calculation tasks: 5  
seminar works: 20  
project design: 0  
final exam: 30  
requirements to take the exam (number of points): 40

**references**

"Mechanics of composite materials", Autar K. Kaw  
"Mechanics and analysis of composite materials", Valery Vasiliev and Evgeny Morozov  
"Mechanics of Elastic Composites", Nicolaie Dan Cristescu, Eduard-Marius Craciun and Eugen Soós  
"Mechanics of Composite Materials with MATLAB" George Z. Voyiadjis and Peter I. Kattan  
"Mechanics of composite materials", Robert M. Jones
Biofluid mechanics

ID: MSc-0332
responsible/holder professor: Stevanović D. Nevena
teaching professor/s: Lečić R. Milan, Stevanović D. Nevena
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: fluid mechanics
semester.position: 2.5

goals

The aim of this subject is getting academic knowledge about fluid dynamical processes in the human body and introducing with scientific methods for predicting, analyzing and studying biological processes caused by biofluid flow.

learning outcomes

Students are qualifying for computing and analyzing by themself biofluid flow processes with contemporary and scientific methods. Also, they obtain the ability to apply these concepts appropriately for modeling biofluid flow in blood vessels, kidneys, lungs and joints.

theoretical teaching

Theoretical lessons contains: fundamental fluid mechanics equations applied on biofluid flow modeling in the human body, basic non-Newtonian fluid models pertaining to human blood flow, blood rheology, cardiovascular system and related diseases, circulatory system, stationary model for blood flow calculation, pulsating blood flow model, define velocity, pressure and flow rate in the blood vessels, the pressure wave propagation caused by heart pulsation, function of the heart valves and their damage influence on the circulatory systems, blood flow and diffusion process in kidneys, diffusion process in haemodialyser, blood and air flows in the lungs, joint friction.

practical teaching

Practical lessons contains: application of the basic fluid mechanics equations, exact solutions for channel and pipe Newtonian fluid flows, creating and solving mathematical models for blood vessels flow, solving models for stationary blood flow in rigid and elastic blood vessels, modeling pulsating fluid flow, calculation of the pressure wave propagation, calculation of the velocity, pressure and flow rate in blood vessels, modeling and calculating diffusion process among blood vessels walls and tissues and application on the haemodialys process and renal flow.

prerequisite

Passed exams in Mathematics and Fluid mechanic b.

learning resources


number of hours
total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 9
laboratory exercises: 0
calculation tasks: 6
seminar works: 10
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 4
check and assessment of projects: 0
colloquium, with assessment: 4
test, with assessment: 2
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 40
laboratory exercises: 0
calculation tasks: 5
seminar works: 20
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references

Biofuels in combustion processes

ID: MSc-0894
responsible/holder professor: Manić G. Nebojša
teaching professor/s: Jovanović V. Vladimir, Manić G. Nebojša, Stojiljković D. Dragoslava
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: engineering materials and welding, tribology, fuels and combustion
semester.position: 2.5

goals


learning outcomes

Upon the successful completion of this course students will be able to:
1. overview of directives and regulations for promotion of use as well as potential of different biofuels in Serbia
2. define resources and properties of plant raw materials for biofuels production.
3. Have an advanced understanding of biofuel and biomass production.
4. Perform technical, economic and environmental comparisons of various energy systems.
5. Critically appraise logistical issues associated with implementing large scale biofuel and biomass energy production.
6. Apply sustainability criteria to various energy systems and evaluate the results.
7. Evaluate the potential of different fuels and energy technologies.
8. be able to better predict the consequences of their energy choices as the next generation of energy users.

theoretical teaching


practical teaching


**prerequisite**

No special requirements.

**learning resources**


**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 8
laboratory exercises: 18
calculation tasks: 4
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 1
check and assessment of lab reports: 3
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 1
test, with assessment: 5
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 40
laboratory exercises: 10
calculation tasks: 5
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

**references**
Computer Simulation in Manufacturing Automation

ID: MSc-0722
responsible/holder professor: Jakovljević B. Živana
teaching professor/s: Jakovljević B. Živana
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: production engineering
semester.position: 2.5

goals

The objective of this course is that students: acquire knowledge and skills needed for practical problems solving in manufacturing automation using computer simulation; to master the methods used for computer simulation modeling and implementation in manufacturing automation; to obtain the knowledge regarding the systematic approach to the project of computer simulation in manufacturing automation; to develop critical approach to the effects of computer simulation application in automation; to get familiar with the role of computer simulation within digital factory

learning outcomes

After successfully completing this course, the students should be capable to:
- Create and implement stochastic simulation;
- Create conceptual model for discrete event simulation;
- Create and implement discrete event simulation within fixed and flexible automation framework;
- Create conceptual and computer model for continuous simulation of various processes;
- Integrate continuous and discrete event simulation;
- Manage discrete event simulation project.

theoretical teaching

1. Introduction to computer simulation: simulation objectives; advantages and disadvantages of simulation; phases of computer simulation development; computer simulation in manufacturing automation; a variety of simulation models: continuous and discrete models, deterministic and stochastic simulation
2. Stochastic simulation: sampling methods, random numbers, random number generators, Monte Carlo simulation
3. Discrete event simulation: elements of discrete event simulation, conceptual modeling of discrete event simulation, activity cycle diagram
4. Computer models for discrete event simulation: approaches in model coding: activity based approach, event based approach, process based approach, the three phase approach; comparative analysis of different approaches
5. Discrete event simulation software: general purpose programming languages, application oriented simulation software; definition of simulation model in programming languages and simulation software packages; simulation outputs and results presentation; application of computer graphics and animation in simulation; application examples of simulation software
6. Discrete event simulation application in automation: generation of conceptual and computer models of fixed, programmable and flexible automation
7. Discrete event simulation project: system definition, generation of simulation model, model
verification and validation, simulation experiments, results presentation and documentation

8. Continuous system simulation: continuous systems modeling, basic principles of numerical integration, modeling of the examples of continuous systems in manufacturing automation, programming languages and software for continuous system simulation, integration of continuous simulation into discrete event simulation

9. Digital factory and simulation: concept and models of digital factory; the role of simulation in digital factory: plant design and optimization, operational management and optimization

**practical teaching**

Laboratory exercises:
1. Monte Carlo simulation
2. Discrete event simulation software: ARENA – basic functioning principles and simulation examples
3. Discrete event modeling and simulation: examples of fixed and flexible automation
4. Continuous systems simulation: modeling and simulation of specific examples in the area of manufacturing automation using general purpose programming language and in application oriented simulation software – ARENA

Discrete event simulation project:
Students work on project dealing with the development of a simulation of a chosen flexible manufacturing system. During project realization students systematically implement all phases of discrete event simulation project: conceptual modeling, model coding, animation generation, model verification and validation, experimentation, analysis of the simulation results. The output is the report and project presentation at the end of semester

**prerequisite**

none

**learning resources**

Jakovljevic, Z., Computer simulation in manufacturing automation – lecture handouts
Computer classroom – each student individually works on a computer
Arena Simulation Software by Rockwell Automation
General purpose programming language

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 1
check and assessment of seminar works: 0
check and assessment of projects: 1
colloquium, with assessment: 0
test, with assessment: 8
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 30
requirements to take the exam (number of points): 30

references

Carrie, A., Simulation of Manufacturing Systems, John Willey and Sons, New York, 1988
Robinson, S., Simulation: The Practice of Model Development and Use, John Willey and Sons, New York, 2004
Pidd, M., Computer Simulation in Management Science, John Willey and Sons, New York, 2004
Design computations in turbomachinery

ID: MSc-0444
responsible/holder professor: Nedeljković S. Miloš
教学 professor/s: Božić O. Ivan, Nedeljković S. Miloš
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: hydropower engineering
semester.position: 2.5

goals

Mastering knowledge of engineering numerical turbomachinery design. Capacity to work in the design and development offices in the turbomachinery industry. Training for innovation of design methods and acquiring the basis for academic upgrading in computational fluid mechanics application.

learning outcomes

After finishing this course, the students will be able to:
1. Apply different calculation methods for turbomachinery design,
2. Compare geometry and energy characteristics of turbomachines obtained by application of different calculation methods,
3. Conduct engineering calculations, with application of contemporary software for geometry design (CAD) and flow calculations (CFD) in turbomachines.
4. Have the skill to work in computerized environment.
5. To analyze and have the skill to present the results of calculation.

theoretical teaching


practical teaching

Numerical examples of the teaching material on the application of computers in the design calculation of the rotating impeller and stationary elements, in hydraulic and strength calculations using the methods of interpolation, regression, integration and differentiation. Calculations of radial turbomachinery - shaping of the meridional section, the approximate orthogonality between the streamlines and normals; grids of constant meridional velocities and potential grids, CFD calculations of flow, development of radial and axial blades numerically; CAD presentation of the developed blades. Shaping design of spiral casing. Single and double spiral casing. Numerical setting of the spiral casing radial section. Numerical calculation of axial pumps stay vanes.

450
prerequisite


learning resources

Handouts for lectures and exercises. References. Faculty computer classroom. Laboratory for Hydraulic Machines - spatial layouts of blades of radial and axial machines, and other elements that are calculated.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 10
calculation tasks: 5
seminar works: 10
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 10
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 20
calculation tasks: 10
seminar works: 40
project design: 0
final exam: 30
requirements to take the exam (number of points): 21

references
Design of construction and mining machines subsystems

ID: MSc-0791
responsible/holder professor: Bošnjak M. Srđan
teaching professor/s: Bošnjak M. Srđan, Gnjatović B. Nebojša
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: material handling, construction and logistics
semester.position: 2.5

goals

Basic course goals (objectives): 1) introducing students to specificity of working process, construction, design and calculation of fundamental subsystems of construction and mining machines; 2) mastering practical skills which are necessary for design and calculation of construction and mining machines.

learning outcomes

This course offers the following skill set to the students who complete it:
• Design of backhoe excavators’ working devices;
• Design of basic elements of single-bucket excavators’ working devices;
• Modeling and calculation of a bucket wheel excavator’s working device – bucket wheel body and buckets;
• Design and calculation of the bucket wheel drive system;
• Design and calculation of four and eight-wheel bogie of a crawler mechanism;
• Calculation of basic technical and technological parameters, power and strength of jaw and conic rock crushers;
• Load analysis, modeling, proper supporting, loading and finite element analysis of civil and mining machines’ fundamental subassemblies.

theoretical teaching


practical teaching

construction and calculation of bucket wheel drive. Design and calculation of four wheel and eight wheel bogie of bucket wheel excavator crawler travel gear. Calculation of basic technical-technological parameters, power and strength of jaw and cone crushers. Construction documentation. Consultations.

**prerequisite**


**learning resources**

Srđan Bošnjak, Bucket Wheel Trenchers, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, 2001., Srđan Bošnjak, Handouts, University of Belgrade, Faculty of Mechanical Engineering, Belgrade.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 20

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 30
requirements to take the exam (number of points): 35

references

Vinko Jevtić - Construction and Mining Machines, Faculty of Mechanical Engineering Nis, 1993.
Design of logistic and warehouse systems

**ID:** MSc-0420  
**responsible/holder professor:** Petrović B. Dušan  
**teaching professor/s:** Bugarić S. Uglješa, Petrović B. Dušan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** industrial engineering  
**semester.position:** 2.5

**goals**

Achieving competency and academic skills in the process of industrial system design. Special emphasis is focused on development of creative skills and overwhelm with specific practical skills needed for professional practice using operational research methods, procedures of analysis and synthesis for obtaining final goal which is optimal practical solution.

**learning outcomes**

Curriculum overcome enables converge of the following skills: analysis, synthesis and prediction of solutions in design process based on knowledge applying in practice using professional ethics as well as development of crucial and self-critical thinking and approach.

**theoretical teaching**

Logistic system in industrial environment (connection of production system with transport system, management of demand and purchase and warehouse system). Design system documentation (fusibility study, conceptual solution, conceptual design, tender documentation, main technological-mechanical project, other main projects, final contractor project and project of carried out state). Previous analysis needed for system design (general conditions for urban planning, logistics and transport connections, energetic potential). Design process procedure. Project realisation and generation of results.

**practical teaching**

Audit lessons (Introduction in design process for defined logistic-distribution system. Activity analysis for forming conceptual solution and conceptual design, activities connected with choosing of technological and other equipment, activities on forming main technological-mechanical project and final contractor project). Project workmanship (Workmanship of the logistic-distribution system project. Defining of necessary parameters and surroundings for the given system design. Defining of needed system capacities. Forming of assignments for the other projects. Realisation of main technological-mechanical project).

**prerequisite**

There is no special conditions needed for course attending

**learning resources**

6. Practical instruction in industrial environment.
7. Personal computers.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 4
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 26
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 4
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 40
final exam: 30
requirements to take the exam (number of points): 30

**references**
Gas Dynamics

ID: MSc-1011
responsible/holder professor: Milićev S. Snežana
teaching professor/s: Milićev S. Snežana, Ćoćić S. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: fluid mechanics
semester.position: 2.5

goals

The student should:
1. acquire basic theoretical knowledge in the field of gas dynamics;
2. be trained to perform basic engineering calculations of compressible flows;
3. become familiar with the basic procedures for experimental research in gas dynamics.

learning outcomes

Attendance and regular monitoring of the theoretical and practical training the student should master the basic knowledge in the field of gas dynamics. This will enable him, on the one hand, to solve specific engineering problems in the elementary problems of compressible flows, and, on the other hand, help him to better understand other courses based on this scientific area.

theoretical teaching


practical teaching

prerequisite

Passed exam in course Fluid Mechanics B

learning resources


number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 20
laboratory exercises: 0
calculation tasks: 10
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 4
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 4
test, with assessment: 2
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 50
laboratory exercises: 0
calculation tasks: 10
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Handouts
Tables for calculation of compressible flows with theoretical handouts, Snežana S. Milićev, Aleksandar S. Ćoćić, Faculty of Mechanical Engineering, 2017.
Compressible Fluid Flow, M. A. Saad
Modern Compressible Flow, J. D. Anderson
Helicopters

ID: MSc-1131
responsible/holder professor: Simonović M. Aleksandar
教学 professor/s: Svorcan M. Jelena, Simonović M. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: aerospace engineering
semester.position: 2.5

goals

1. Introduction to rotary lifting surface vehicles.
2. Introduction to rotor aerodynamic theory.
3. Design of helicopters.
4. Performance of helicopters.

learning outcomes

1. Understanding of aerodynamic VTOL schemes.
2. Selection of the aerodynamic scheme in helicopter design.
3. Mastering theoretical foundations of rotary wing aerodynamics.
4. Ability to calculate aerodynamic and performance characteristics of the helicopter.
5. Ability to design rotor blade.
6. Ability to conceptually design helicopter.
7. Ability to apply modern software tools in design of helicopters.
8. Ability to optimize helicopter design parameters.

theoretical teaching

In theoretical part the following is taught: VTOL aircraft, Theory of ideal rotor, Blade element theory, horizontal flight of a helicopter, vertical flight performances, horizontal flight performances, Stability of a helicopter, design schemes of a helicopter, helicopter control, Design of rotor blade. EASA regulations for helicopter and transmission design.

practical teaching

Theory is applied to chosen helicopter. Practical work of the student is monitored by MOODLE. Lectures are downloaded using online access. Homework and other materials to master lectures are supplied. Students do projects in a group and finally present results to other students.

prerequisite

Suggested: Aerodynamic design

learning resources

Lectures in electronic form. Simulations and movies are accessible via MOODLE and internet.
number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 5
seminar works: 0
project design: 0
consultations: 10
discussion and workshop: 5
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 15
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 55
project design: 0
final exam: 30
requirements to take the exam (number of points): 25

references

J. Gordon Lishman, Principles of Helicopter Aerodynamics, Cambridge University Press
A. R. S. Bramwell, Helicopter Dynamics, Edvard Arnold,, 1976
Industrial Automation

**ID:** MSc-0599  
**responsible/holder professor:** Ristanović R. Milan  
**teaching professor/s:** Ristanović R. Milan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** control engineering  
**semester.position:** 2.5

**goals**

To introduce students to the contemporary industrial control systems, design and technology of their realization, component selection and practical implementation of simple solutions.

**learning outcomes**

The acquired knowledge is used in engineering practice. The student is competent to understand modern control systems in the industry, component selection and practical implementation of simple solutions.  
Student is able to implement simple solutions of electric, pneumatic and electropneumatic control.  
Student is able to create project with Simatic S7-1200 PLC in programming language STEP 7 V12 according to the standard IEC 61131-3. Student is trained to solve problem of sequential and real time control.  
Student is able to create HMI project with operators panel.

**theoretical teaching**


**practical teaching**

Examples of implemented systems. Practical aspects of election management system components. Realization of simple solution in electrical, pneumatic and electro-pneumatic technology. PLC controllers programming. Development of SCADA system.

**prerequisite**
Attended courses in automatic control, computer control and digital systems.

**learning resources**

M. Ristanovic, Industrial Automation, printed lectures
Laboratory for Industrial Automation
Siemens SIMATIC S7-1200
Siemens SIMATIC KTP-600PN
Siemens SIMATIC LOGO!
TIA PORTAL - licensed software

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 45

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 5
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 3
test, with assessment: 0
final exam: 2

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 50
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 10
final exam: 30
requirements to take the exam (number of points): 50

**references**
Stenerson J., Industrial automation and process control, Prentice Hall, 2003
Model Based Development of Automotive Software

ID: MSc-1088
responsible/holder professor: Miljić L. Nenad
teaching professor/s: Miljić L. Nenad
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: project design
parent department: internal combustion engines
semester.position: 2.5

goals

The aim of the course is to provide comprehensive insight into the methods and state-of-the-art tools for development and designing of embedded Automotive software; To provide students with knowledge needed for recognizing and accurate formulation of the automotive system tasks which could be realized through an embedded platform solution; To teach student how to use available methods, like model based modeling approach, and software tools for designing embedded automotive solutions with reliable software components.

learning outcomes

Upon the course completion, the student should be capable to:
● Recognize and Analyze the problem which could be solved through an embedded platform solution.
● Prepare specification of needed hardware and software components.
● Develop, implement and test software components.
● Test embedded component, both on a component and integrating system level.
● Calibrate models built in software components.

theoretical teaching

Introduction to the automotive control systems; Real-time systems and their application in automotive embedded solutions; Distributed computing solutions and automotive networks; Basics of AUTOSAR; Applicable standards in the process of Automotive software development; Software development process models; V Automotive model; Model based development; Automotive software modelling basics; Methods and tools in Automotive software development; Automotive software maintenance methods, tools and procedures;

practical teaching

Training: ETAS ASCET development environment; Development of automotive software components - from a concept to testing and calibration through series of guided examples.

prerequisite

No particular requirements for attending this course

learning resources

Handouts: Model base development of Automotive Software, available on the Moodle LMS platform of the IC Engines Dept.
Modeling and development environment: ETAS ASCET
number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 15
laboratory exercises: 19
calculation tasks: 0
seminar works: 0
project design: 15
consultations: 0
discussion and workshop: 1
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 0
final exam: 0

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 70
final exam: 30
requirements to take the exam (number of points): 55

references

Dieter Nazareth: Model Based Development of automotive Software, ETAS 2011
Multifase Flow

ID: MSc-0457
responsible/holder professor: Crnojević D. Cvetko
teaching professor/s: Lečić R. Milan, Crnojević D. Cvetko
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: fluid mechanics
semester.position: 2.5

goals

In the field of multiphase flow is particularly important to study the problems such as fluidization, pneumatic conveying, hydraulic transport, pneumo-hydraulic lifts, cavitation, evaporation, condensation and two-phase flow. The main objective of this course is to master the knowledge, calculation models and the relevant practical skills that treat problems of one-dimensional multiphase flow in pipes and channels.

learning outcomes

theoretical teaching

practical teaching

prerequisite

learning resources

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 25
laboratory exercises: 3
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 8
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 35
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 50
requirements to take the exam (number of points): 20

**references**
New generation of machine tools and robots

ID: MSc-1107
responsible/holder professor: Živanović T. Saša
Teaching professor/s: Živanović T. Saša, Slavković R. Nikola
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: production engineering
semester.position: 2.5

goals

1. Perception of different levels of the new generation of machine tools and robots concept.
2. Acquisition of basics of reconfigurable, high-speed, meso- and micro-machines and high accuracy machine tools.
3. Practical knowledge about parallel kinematic machines and machines for material addition processes and multi-axis machining.
4. Development of programming skills relevant for the new generation of machine tools and robots.
5. Development of report-making skills.

learning outcomes

After completed this course the students should be able to:

• Understand the role, importance, types and applications of the new generation of machine tools and robots.
• Understand different levels of the new generation of machine tools and robots concept.
• Select appropriate new generation machine tools and robots for given technological task.
• Select and prepare environment for operation of machine tools and robots.
• Programming the new generation of machine tools and robots.
• Use new programming methods for numerically controlled systems.

theoretical teaching

New teaching contents:
T1. Definition and classification of the new generation of machine tools and robots.
T2. Reconfigurable machine tools.
T3. High-speed machine tools.
T4. Machines for material addition processes.
T5. Parallel kinematic machines concepts.
T6. Identification of geometry and kinematics in parallel kinematic machines.
T7. Multi-axis machine tools.
Extension:
(a) Extension of T1 and calculation tasks relevant for parallel kinematic machines geometry.
(b) Extension of T2 and calculation tasks relevant for parallel kinematic machines.
(c) Extension of T3 using the examples of meso- and micro-machines.
(d) Extension of T4 using the examples of machine tool calibration.
(e) Extension of T5 using the examples of compensations in the machining system.

**practical teaching**

Practical teaching involves auditorial exercises, laboratory work and seminar work writing.

1. Auditorial exercises: (1) Resources for studying the new generation of machine tools and robots. (2) Analysis of reconfigurable machines. (3) Machine tool calibration and compensations in the machining system.

2. Laboratory exercises: (1) Programming of machines for material addition processes. (2) Programming of DELTA robot. (3) Programming of parallel kinematic machines. (4) Programming of multi-axis machining. Instructions are provided for each exercise and the necessary work sheets.

3. A seminar work on the new generation of machine tools and robots.

4. A report is written on the knowledge acquired during the course according to instructions and model provided at the start of the course. A part of the report is a seminar work.

**prerequisite**

Study curriculum and student motivation for learning about machine tools and industrial robots according to the goals set and outcomes offered.

**learning resources**


2. Documents for the areas of parallel mechanisms and multi-axis machining of robots.


11. LPI-1: Two work-places equipped with prototypes of the new generation of machine tools (3-axis parallel milling machine, desktop 3-axis parallel milling machine).


15. CSP-1: Two work-places equipped with the software for programming of multi-axis machining.

**number of hours**

Total number of hours: 75
active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 5
laboratory exercises: 21
calculation tasks: 0
seminar works: 4
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 1
check and assessment of seminar works: 1
check and assessment of projects: 0
colloquium, with assessment: 3
test, with assessment: 5
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 50
laboratory exercises: 10
calculation tasks: 0
seminar works: 10
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references

Ship strength 2

**ID:** MSc-1017  
**Responsible/Holder Professor:** Momčilović V. Nikola  
**Teaching Professor/s:** Momčilović V. Nikola  
**Level of Studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**Final Exam:** written  
**Parent Department:** naval systems  
**Semester Position:** 2.5

**Goals**

The aims of the course are to explain the basic principles of numerical methods for structural analysis, theoretical and practical fundamentals of finite element method and to provide a thorough explanation of finite element method application in ship structure design.

**Learning Outcomes**

1. A thorough knowledge about the concept of structural analysis by applying finite element method as one of the most significant methods for structural analysis in contemporary engineering practice.  
2. Qualification for practical application of a commercial FEM program package in direct computations of ship structure.

**Theoretical Teaching**

Teaching focuses on the finite element method as one of the most significant numerical methods for structural analysis in contemporary engineering practice. The idea is to organize the course as a first encounter with finite element method for those students for whom it is not a major subject of study but only one of the tools they have to master to manipulate. That is why a portion of approach is simplified, where it is not insisted upon all details of mathematical derivations but upon aspects essential to proper practical FEM analysis by applying commercial program packages.

**Practical Teaching**

The student is trained to independently do computations for typical models of ship structure by using a computer and commercial program packages. It is started from less complex beam models – ship’s cross-sectional frames and plane hull structure grids, and through models of stiffened and unstiffened panels, involving thin plate finite elements, it is gradually arrived at complex web frame and three hold models.

**Prerequisite**

Exam passed in Ship Strength 1.

**Learning Resources**

1. Commercial FEM computer programs. 2. Instruction manual for commercial FEM programs use. /In English/.

**Number of Hours**
total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 18
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 5
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 50
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 40

**references**

Statistical analysis in mechanical engineering

ID: MSc-0503
responsible/holder professor: Veljković A. Zorica
teaching professor/s: Veljković A. Zorica
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: information technologies
semester.position: 2.5

goals

Goals of the course are introduction of basic and up-to date statistical methods for engineering practice. Main goals of the course is identification of problems, methods for their solving, defyng problem solving procedures and systems for decision making, based on obtained results, i.e. interpretation of numerical results for use in practice. Analyses of large sets of data are especially emphases.

learning outcomes

After successfully completed course, students obtained knowledge of statistical methods and their use for solving specific problems in practice. They should be able to define the problem, identify and apply adequate statistical procedures and obtain competent answers. During the course students master the procedures for use of adequate statistical methods. It is expected that students could be able for interpretation of statistical results for their practical usage. Also it is expected that students can use and work in available statistical software.

theoretical teaching

Course include following subjects: Basic definitions and descriptive statistics; Discrete and continuous probability distributions for random variables, their characteristics, statistics and moment generating functions. This part include distributions such as uniform, binomial, Poison, normal, log-normal, weibul, gamma, beta, exponential etc; Tests of hypothesis is divided on parameter and nonparametric testing. Parameter testing includes one and two sample tests for means, proportion and variance. Nonparametric testing include goodness of fit by Kolmogorov test, comparison tests for distributions such as Mann Whitney test, Kolmogorov-Smirnov test, sign test, Darling Anderson test, Wilcoxon tests for median; Simple linear and multiple regression and correlation for large data using matrix approach, model building, testing of adequacy of the models, and forecasting. Problems for nonlinear regression are solved by use of multiple regression and orthogonal polynoms; One-way and two-way analysis of variance, followed by design of experiments, i.e. full and fractional factorial design and Taguchi's approach.

practical teaching

Exercises follow the contents of lectures by examples and problem solving in available statistical software.

prerequisite

No conditions, it is preferable to have knowledge from other MIT courses.
learning resources

http://mit.mas.bg.ac.rs

All materials for successful following of the course - handouts, materials for exercises and projects are available to students before lectures in electronic form. (in Serbian)

Radojević S, Veljković Z, Kvantitativne metode, CD. MF (in Serbian)

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 15
laboratory exercises: 15
calculation tasks: 10
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 3
check and assessment of lab reports: 4
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 6
test, with assessment: 0
final exam: 2

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 50
laboratory exercises: 0
calculation tasks: 15
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 31

references
Radojević S, Veljković Z, Kvantitativne metode, CD. MF
Thermal Turbomachinery

ID: MSc-0337

responsible/holder professor: Petrović V. Milan
teaching professor/s: Banjac B. Milan, Petrović V. Milan

level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral

parent department: thermal power engineering
semester.position: 2.5

goals

1. The achievement of academic competence in the field of steam and gas turbines and thermal power engineering.
2. The achievement of theoretical knowledge about how to transform heat into mechanical work learning thermodynamic processes and equipment (steam and gas turbines and thermal power plants).
3. The acquisition of practical knowledge to optimize thermodynamic cycle and steam and gas turbines.
4. The achievement of the techniques of process modeling.
5. Mastering the methods of experimental work in thermal power engineering.

learning outcomes

1. Academic deep knowledge of the thermodynamic cycle and flows in steam and gas turbines and turbine plants
2. The development of critical thinking about energy use, fuel efficiency and environmental preservation
3. The ability of calculate heat balance diagrams and main parameters of the steam and gas turbine power plants.
4. Ability to use computer technology for modeling and calculations

theoretical teaching

1) Thermodynamic background of the steam turbines and steam turbine power plants. Thermodynamic improvements of the thermodynamic cycles.
2) Reheat. Regenerative feed water heating. The basic thermodynamic cycle.
3) Steam turbine power plant - the 1st and 2nd law of thermodynamics.
4) Cascades of the steam turbine. Geometry and operating parameters. The main aerodynamic parameters of the steam turbines cascades.
5) The aerodynamic losses in the cascades.
6) 1D theory of elementary stages of steam turbines. Euler equation for the turbine. Efficiency of the stage
7) Axial impulse stage. Axial reaction stage. Internal efficiency of the stage. Internal losses degrees.
8) Thermodynamic basis of the gas turbine plant. The basic thermodynamic cycle. The basic and main thermodynamic parameters of the gas block.
10) Balance of energy of the gas turbine plant. Possibilities to improve the thermodynamic gas turbine plant. More complex configurations of gas turbine plant. Combined gas and
steam plant turbine.

**practical teaching**

Practical teaching is carried out through:
Auditory exercises: basic principles. Historical development. Classification and application of steam turbines. Explanation of the heat balance diagrams and the functioning of components of the steam turbine plants. Instructions for calculation of the heat balance diagram and the main thermodynamic parameters of the steam turbine plants. Instruction to create an energy balance of the steam turbine plant according to the 1st and the 2nd law of thermodynamics.
Labs: Experimental determination of the specific steam consumption of steam turbines at the Laboratory of Mechanical Engineering.
Project design: Calculation of the heat balance diagram, the main thermodynamic parameters and the balance of the steam turbine plant.

**prerequisite**

Passed exams in Thermodynamics and Fluid mechanics

**learning resources**

Petrovic, M.: Instruction for steam turbine projet, Belgrade, 2004
Petrovic, M.: Scripts and handouts for Steam turbines
Instructions for performing laboratory exercises
Software package for calculating of properties of steam and water.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 14
laboratory exercises: 4
calculation tasks: 0
seminar works: 0
project design: 12
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 1
check and assessment of seminar works: 0
check and assessment of projects: 7
colloquium, with assessment: 0
test, with assessment: 2
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 10
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 50
requirements to take the exam (number of points): 25

references

Stojanovic, Thermal Turbomachinery, Gradjevinska knjiga, Belgrade, 1967.
Tribotechnique

ID: MSc-0509  
**responsible/holder professor:** Vencl A. Aleksandar  
**teaching professor/s:** Vencl A. Aleksandar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** engineering materials and welding, tribology, fuels and combustion  
**semester.position:** 2.5

**goals**

The student attending this course should:
- Master the fundamental knowledge in the areas of lubricants and lubrication;
- Comprehend the significance of failures from the technical and economic aspects;
- Master the skills to evaluate the failure according to the established cause-consequence classifications;
- Comprehend the issue of establishing a diagnostic of machine condition and monitoring programme;
- Increase the availability and productivity of the equipment through a clearly defined technical strategy and to make competent decisions on it.

**learning outcomes**

Based on the mastered knowledge the student is qualified to:
- Conducts an analysis of the problems connected with maintenance and competently decides on the maintenance program in the tribotechnique area;
- Describes and distinguishes types of liquid, semi-liquid, gaseous and solid lubricants and their basic characteristics;
- Choose the appropriate lubricant and method of lubrication for the basic machine elements and mechanical systems;
- Selects and uses the modern methods for condition-diagnostic and condition-monitoring of the tribological systems;
- Make conclusions, based on monitoring results, about ways how to prevent the failure;
- Carry-out all the maintenance measures in tribotechnique domain and systematically introduce them into the working practice with the aim to reduce the losses due to friction and wear.

**theoretical teaching**

- Introductory lecture – The objectives and tasks of tribotechnique.
- Lubricants – role, type, classification and basic properties.
- Forms and types of lubrication; Hydrostatic, hydrodynamic, elastohydrodynamic and boundary lubrication.
- Lubrication systems (tasks and roles; procedures and classification; elements definition); Selection of lubricants and lubrication of the main machine elements and mechanical systems.
- Lubrication services organization and lubricants ecology.
- The role, objectives and techniques of failure analysis and condition-diagnostics in the construction and maintenance of mechanical systems (casual, permanent, partial, immediate and gradual failure); Failure analysis.
• Tribotechnique activities and sustainable development (maintenance methods, road map to excellence, performance benchmark);
• Basic methods of technical diagnostics (diagnostics based on vibration monitoring, diagnosis based on the monitoring of thermal conditions and diagnostics through wear products in the lubrication oil).
• Lubricants monitoring and the diagnostic methods for tribological components and systems condition.

practical teaching

• Classifications and specifications of lubricants; Methods for lubricants testing.
• Laboratory practice: “Experimental methods for evaluation of lubricants basic properties”; Measuring of: flash point and pour point; acid and total base number; foaming tendency; oxidation stability; ash, water and mechanical impurities contents; viscosity and viscosity index.
• Examples of failure analysis techniques (Fault tree analysis, Ishikawa diagram, Pareto analysis, FMEA, etc.) and their application to the specific tribological components failure case studies;
• Presentation of tribological components damages and failures of, and wear products (debris); Presentation of equipment for tribological components diagnostics.
• Project task: A survey of potential types of failures; analyze of the probability, causes and consequences of real and potential failures of the components or systems; using some of the failure analysis techniques (fault tree, Ishikawa diagram, Pareto analysis, FMEA etc.).

prerequisite

No special requirements.

learning resources

1. --, Handouts for each lecture.
3. M. Babić, Lubricating Oil Monitoring, Faculty of Mechanical Engineering, Kragujevac, 2004 (in Serbian).
4. Various devices for measuring the basic characteristics of liquid lubricants and greases; Viscometer for liquid lubricants; Pressure grease viscometer.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 8
calculation tasks: 0
seminar works: 0
project design: 9
consultations: 13
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 3
check and assessment of seminar works: 0
check and assessment of projects: 3
colloquium, with assessment: 0
test, with assessment: 4
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 50
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 10
final exam: 30
requirements to take the exam (number of points): 35

**references**

Two-Phase Flows with Phase Transition

ID: MSc-0325
responsible/holder professor: Stevanović D. Vladimir
teaching professor/s: Milivojević S. Sanja, Stevanović D. Vladimir
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: thermal power engineering
semester.position: 2.5

goals

The aim is acquiring academic knowledge about two-phase flow patterns, mechanisms of transport processes in two-phase flows, intensity of evaporation and condensation and methods for two-phase flows simulation and analyses within design, safety analyses and prescription of operating conditions and parameters of energy plants.

learning outcomes

The students are trained to perform computer simulation and analyses of gas-liquid two-phase flows within design of energy plants, safety analyses, operating conditions diagnostics, defining of operating conditions, etc.

theoretical teaching


practical teaching

Prediction of two-phase flow parameters: static, flow and thermodynamic quality, void fraction, two-phase flow density, superficial velocity, slip factor, drift velocity, etc. Empirical correlations for the prediction of void fraction, slip factor and drift velocity. The influence of the pressure level on the two-phase flow parameters. Prediction of pressure change in two-phase flow. Development of multi-fluid models of two-phase flow: balance equations, closure laws and solving methods. Application of the multi-fluid two-phase flow model to energy and process equipment, such as: evaporating channel, condensation in a pipe, heat exchangers with phase transitions, evaporators, steam boilers with boiling around tubes in a bundle, evaporating tubes in steam boiler furnace, condensers, pressurizers, feedwater tanks, steam boiler drum, steam accumulator, pipelines, etc.

prerequisite


learning resources

485
Course handouts.
Computer equipment.
Computer codes for thermal-hydraulic simulations of two-phase flows and pressure
transients in pipelines, pressurized vessels, heat exchangers with boiling or condensation in
tube bundles.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 5
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 35
laboratory exercises: 30
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**
Stevanovic, V., Thermal-Hydraulics of Steam Generators – Modelling and Numerical Simulation, University of Belgrade, Faculty of Mechanical Engineering, 2006.
Vehicles and Environment

ID: MSc-0874
responsible/holder professor: Blagojević A. Ivan
teaching professor/s: Blagojević A. Ivan, Mitić R. Saša
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: motor vehicles
semester.position: 2.5

goals

The goal of this subject is to give the students an insight into effects vehicles have on the environment. Preservation of the environment and minimization of the negative impacts of driver-vehicle-environment system are the basis of modern vehicle development and exploitation. Therefore a more detailed analysis of these effects in this case are a prerequisite for creating a modern engineer, not only in the field of motor vehicles.

learning outcomes

Upon successful completion of this course, students should be able to:
- Explain the concept of fuel consumption and the possibilities for its reduction;
- Analyze the impacts of driver on fuel consumption;
- Identify and explain the harmful elements of the exhaust emissions of motor vehicles, ways of their formation and effects, methods of measurement and legal constrain values per component;
- Identify alternative vehicle drives and fuels;
- Analyze working principles of hybrid and electric vehicles;
- Explain the impact of noise and vibration produced by vehicle;
- Recognize environmentally friendly and modern materials used in the design and manufacture of vehicles;
- Describe the recycling process and the life cycle of the vehicle.

theoretical teaching

Introductory classes relate to the importance of the vehicle in production, transportation and traffic in contemporary economic and social environment. They are followed by lectures that look back on the development of automotive technology that was largely affected by environmental conditions. The following lectures are divided into blocks according to a rough classification of basic elements of the impact of vehicles and drivers on the environment:
1. fuel consumption; 2. exhaust emission; 3. hybrid and electric vehicle drivetrain; 4. alternative fuels; 5. noise and vibration; 6. recycling and the use of modern materials.
The final lectures are planned to present the future trends in the design and exploitation of vehicles with the aim of improving environmental protection.

practical teaching

By conducting the practical training, students should identify and analyze the impact of the vehicle-driver-environment system on the environment, primarily through fuel consumption and exhaust emission. Through the laboratory classes, parameters of the vehicle engine for different driving modes (speed, acceleration and road conditions) are acquired, providing the
data for students to process in their reports and draw the conclusions. In addition, students explore operating modes of hybrid and electric vehicles and effects of their. Students are also required to write the essay on a given subject.

**prerequisite**

No special requirements.

**learning resources**

Motor vehicle; Vehicle and engine parameters data acquisition system; Hybrid vehicle; Electric vehicle.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0 laboratory exercises: 12 calculation tasks: 0 seminar works: 13 project design: 0 consultations: 5 discussion and workshop: 0 research: 0

**knowledge checks**

check and assessment of calculation tasks: 0 check and assessment of lab reports: 3 check and assessment of seminar works: 4 check and assessment of projects: 0 colloquium, with assessment: 4 test, with assessment: 0 final exam: 4

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 7 test/colloquium: 42 laboratory exercises: 7 calculation tasks: 0 seminar works: 14 project design: 0 final exam: 30
requirements to take the exam (number of points): 40

references
Aircraft control and systems

ID: MSc-1079
responsible/holder professor: Petrović B. Nebojša
teaching professor/s: Peković M. Ognjen, Petrović B. Nebojša
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: aerospace engineering
semester.position: 3.1

goals

Course goal is to introduce students to integrated flight control computer systems, their functions, structures and principles. Course topics enable students to gain detailed insight into modern integration of aircraft systems and its components in aircraft control.

learning outcomes

Upon course completion, students gain knowledge and understanding of existing aircraft integrated control computer systems. Course topics prepare students for studies of more advanced topics of aircraft control systems and further specialization in this area, or, in the case that they are oriented to other aeronautical fields to fully understand complex problems of aircraft control systems.

theoretical teaching

Functions and structure of integrated aircraft control computer systems; System components; Various type of aircraft control systems; Sensors, busses, processors; Displays; Actuators; Flight control systems; Autopilots; Stabilizers; Dynamic models of flight; Longitudinal and lateral dynamic models; Transfer functions; Autopilot synthesis; Autopilot structure; Short period approximation; Gust model; Control command model.

practical teaching


prerequisite

Students must have corresponding semester in which this subject is teaching.

learning resources

Oprema i Sistemi Letelica - Sistemi automatskog upravljanja leta, Janković J. (in Serbian)
Written handouts from the lectures.
Written handouts from auditory exercises.
Internet.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**
Artillery Weapons Design

**ID:** MSc-0101  
**responsible/holder professor:** Micković M. Dejan  
**teaching professor/s:** Micković M. Dejan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 4  
**final exam:** written  
**parent department:** weapon systems  
**semester.position:** 3.1

**goals**

Detailed analysis of design solutions for individual elements of artillery weapons. Detailed study of design methodologies for the main structural elements of weapons. Practical implementation of calculations for basic structural elements of artillery weapon through the realisation of projects.

**learning outcomes**

Mastering the calculation of basic parameters that characterize the function of individual pieces of artillery systems. Acquiring the ability of students to create their own software tool for the design of individual structural elements of artillery weapons. Qualifications for the design of the main structural elements of artillery systems.

**theoretical teaching**


**practical teaching**


**prerequisite**

Without specific conditions for attending the subject. Desirable - passed the exam in the subject Classical Armament Design.
learning resources

1. Micković D.: Design of Artillery Weapons - Handouts

number of hours

total number of hours: 45

active teaching (theoretical)

lectures: 18

active teaching (practical)

auditory exercises: 6
laboratory exercises: 0
calculation tasks: 2
seminar works: 0
project design: 8
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 2
colloquium, with assessment: 2
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 30
requirements to take the exam (number of points): 35

references
Bioaumatics

ID: MSc-0676

responsible/holder professor: Ribar N. Srdan

teaching professor/s: Ribar N. Srdan

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: written

parent department: control engineering

semester.position: 3.1

goals

Introduction to the principles of work of biological systems from the point wiev of automatic control. Spotting and analyses the specificity and complexity of these systems, as control systems.

learning outcomes

Biological systems are the most advanced automation systems. With the emergence of new breakthroughs in technology, such as robotics, artificial intelligence, biotechnology and others it became necessary to study these systems created by nature for the purposes of technique. In the context of the development of techniques more and more demands are posted to expand the traditional frames of automatic control and the study of automatic control system with intelligence.

theoretical teaching


Basics of biotechnical devices and appliances: biosensors, information machines at the molecular level. Control systems in the technique based on knowledge of biological systems work. Application solutions from biological systems work in robotics, bioreactors, human-machine system and other areas of mechanical engineering, electrical engineering and biomedicine.

practical teaching

Basic mathematical models analysis of bioinformation process. Simulation of different mathematical models of nerve cells (Hodgkin-Huxley model, Fitz Hugh Nagumo model) and examples of their qualitative analysis.

prerequisite

Enrolled master studies
learning resources

1. Written material from the lecture (handouts)
2. Matlab, Mathematics and appropriate software tool
3. Material for exercises in electronic form available on the website

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 35

active teaching (practical)

auditory exercises: 10
laboratory exercises: 2
calculation tasks: 4
seminar works: 1
project design: 10
consultations: 1
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 5
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 4
test, with assessment: 0
final exam: 3

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 30
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 40

references

Written material from the lecture (handouts)
Matlab, Mathematics and appropriate software tool
Material for exercises in electronic form available on the website
Design, construction and operation of processing systems

ID: MSc-0363
responsible/holder professor: Petrović LJ. Aleksandar
teaching professor/s: Petrović LJ. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: process and environmental protection engineering
semester.position: 3.1

goals

Objective of the course is to introduce students to different stages of construction, from technical documentation preparation and obtaining the necessary approvals to construction and exploitation. Students learn about with the contents of the project. In the second part of the course acquire basic knowledge related to activities that follow design of processing industry facilities (power supply, operating fluids, transport, water flow etc.). Part of the course deals with the economic evaluation of investments.

learning outcomes

Main outcome of the course is to teach students to independently run object construction. This includes project documentation preparation and object construction. After successful completion of the study program, student is capable to foresee the extent of necessary design work in processing industry, as well as to plan necessary installation for production plants.

theoretical teaching


practical teaching

Introduction to the investment technical documentation. Introduction to the format of mechanical engineering projects. Examples of calculation of technology supported production lines. Examples of drawing technology systems schemes. Designing warehouses and transport systems. Power supply systems. Compressed air supply. Design of facilities for energy supply. Distribution of operative fluids. Budget and validation of investment. Exploitation and investment costs of facility operation. Independent realization of the main machine engineering project according to the predefined project task.

prerequisite
Defined with curriculum of study program / module

**learning resources**


**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 20

**active teaching (practical)**

auditory exercises: 25
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 3
test, with assessment: 2
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 50
requirements to take the exam (number of points): 30

**references**
Handouts
Designing software for mechanical engineers

ID: MSc-1148

responsible/holder professor: Mitrović B. Časlav

teaching professor/s: Bengin Č. Aleksandar, Mitrović B. Časlav

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: written+oral

parent department: information technologies

semester.position: 3.1

goals

- Prepare inputs for the engineering software based on standard calculations.
- Preparation of engineering calculations for effective programming and obtain efficient programs.
- Testing and verification of software engineering. Validation of software engineering.
- Use SQL to get information from databases.
- Use SQL for engineering decision making.
- Organization, normalization of data in the database.
- Privacy, data archiving. Issues of software licensing.

learning outcomes

After successful completion of the program provided for in this case the student can:

- Prepare a budget for programming.
- to assess the quality of information obtained from the input data that are processed program written for a defined budget.
- use the database for specific problems in mechanical engineering.
- use SQL as a generator of low-level information for software engineering.

theoretical teaching

1. Basic numerical methods in the calculations.
4. Relational algebra, relations, and indexing. Basic SQL commands to create objects.
5. Basic SQL commands to update the object and relational operations.
7. Software Licensing.

practical teaching

It consists of the auditory, laboratory exercises that accompany the course. Case Studies. The commemoration of the database design, different tools. Database-based storage of drawings, photographs and complex objects.

prerequisite

Database design. Software Engineering. C/C++
learning resources

The necessary software for this case under the GNU license - free of charge. If you use Linux you needed Python is readily available. If you use another operating system, Python can be downloaded from the appropriate Web site (see URL) or the URL. To run the software necessary to possess enough simplest PC.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 11
laboratory exercises: 19
calculation tasks: 0
seminar works: 5
project design: 2
consultations: 0
discussion and workshop: 3
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 7
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 3
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 35
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Energy Planning

**ID:** MSc-0105  
**responsible/holder professor:** Stevanović D. Vladimir  
**teaching professor/s:** Milivojević S. Sanja, Petrović V. Milan, Stevanović D. Vladimir  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** thermal power engineering  
**semester.position:** 3.1

**goals**

The aims of the subject are to master the methods for the analyses and planning of the macro energy systems at the level of economy and industry sectors, regions and the country, including analyses and formation of energy balances, prediction of energy flows and the structure of energy consumption, classification of energy carriers and indicators of energy consumption, the relation between the economic growth and energy consumption, the state regulative in the energy sector, the environmental impact of energy consumption etc.

**learning outcomes**

Students acquire a knowledge and skills related to energy planning by using statistical and econometric methods and by applying the phenomenological models, as well as related to methods for providing the basis for planning procedures, such as analyses and preparation of energy balances, prediction of indicators of energy consumption, etc.

**theoretical teaching**


**practical teaching**

Macro energy systems balancing, prediction of energy, economic and technological indicators of energy consumption, optimization and usage of energy plants for electricity production, planning of energy needs, electricity production costs, optimization of dimensions and operational parameters of energy plants and equipment, measures for rational energy consumption, methods for economic evaluation of energy efficiency measures (the net present value method, the internal rate of return method and the pay back period).

**prerequisite**

Passed exams in Thermodynamics and one subject within the Module for Thermal Power Engineering.
learning resources

Handouts.
Ristic, M., General energetics, Faculty of Mechanical Engineering, Belgrade, 1981.
Personal computers.
Software for energy planning and economic evaluation of investments.
Internet presentations of International Energy Agency and World Energy Council.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 20
laboratory exercises: 0
calculation tasks: 10
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 10
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 65
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references
Geoinformation and remote control of biotechnic systems

ID: MSc-0615
**responsible/holder professor:** Marković D. Dragan
**teaching professor/s:** Simonović D. Vojislav
**level of studies:** M.Sc. (graduate) academic studies
**ECTS credits:** 6
**final exam:** written+oral
**parent department:** agricultural engineering
**semester.position:** 3.1

**goals**


**learning outcomes**

After successful completion of this course, studenty should be able to:
• Identify the different components of the automation system biotechnical,
• Define procedures for precision farming,
• Interpret hydraulic and pneumatic scheme of agricultural machinery,
• Projected guidance direction of agricultural machinery,
• Organize a complete cycle of precision farming,
• Communicate effectively in a multidisciplinary team.

**theoretical teaching**

1. Introductory discussion of theoretical bases and methods of measurement and automation of agricultural machines and equipment: navigation leveling measurements, measuring distance (distance, measuring the number of revolutions and torque measuring yield loss measurement, the measurement of quantity and measurement of other parameters; 2 Principles of measurement, sensors , division, operating principles, static and dynamic characteristics, a method of measuring non-electrical quantities on agricultural machines and equipment, can bus system; third Automation tractors and machinery: automatic control of loading, automatic control of connection devices and machines on the tractor, the tractor can bus , automatic control and information systems; 4 combines automation: automatic control of the direction, regulation of the position Header, perform separation and other technological devices (automatic leveling), measurement and regulation of losses, monitoring of combine harvesters; fifth management in precision agriculture GPS and DGPS and automation systems and production lines in food processing industry.

**practical teaching**

Laboratory exercises:
1. Measurements of kinematic characteristics of agricultural machinery and equipment;
2. Measurements of energy parameters of agricultural machines and equipment.
Essay by selecting candidates from the field:
1. Automation of tractors and agricultural machines and devices;
2. Automation of universal self-propelled combine harvesters;
3. Automation of self-propelled harvester for vegetables and industrial crops;
4. Automation equipment and technological lines for food processing;
5. Application of GPS and DGPS in precision food production (Precision Farming).

prerequisite

Attended courses of previous years of study and all the conditions defined curriculum of study program / module

learning resources

3. Automation and measurement of agricultural machinery-handouts.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 10
calculation tasks: 10
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 5
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 3
test, with assessment: 2
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 20
calculation tasks: 20
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 50

references

Ribar Z., Control systems, MF in Belgrade, Belgrade 2008.
Popovic M., Sensors and measurements, Department of textbooks and teaching aids, Srpsko Sarajevo, 2004.
Hydropower plants and equipment

ID: MSc-0810
responsible/holder professor: Božić O. Ivan
teaching professor/s: Božić O. Ivan, Ilić B. Dejan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: hydropower engineering
semester.position: 3.1

goals

Achieving academic competence in the field of hydropower plants, equipment and hydro energy.
Obtaining practical knowledge in hydropower plants designing and the content of the technical project documentation.
Mastering knowledge of how to choose and calculate hydromechanical equipment installed in hydroelectric and pump stations.
Developing the ability to find the optimal solution by combining a wide range of acquired theoretical and practical knowledge and using multicriteria methods.
Improving individual creative abilities in performing professional design of hydro energy systems.

learning outcomes

On successful completion of this course the students will be able to:
- define, plan and organize the phases of project design, build up and operation of hydropower plants within electro energy and water supply systems,
- design the optimal hydro mechanical equipment (trash racks, valves, pipes etc.),
- apply the empirical data to the choice and calculation of hydraulic machinery and equipment with the aim of high efficiency operation of hydro power plants and pump stations,
- analyze the transient operating regimes and unsteady fluid flow (water hammer) in various energy systems,
- collect, analyze and present the calculation results,
- choose the optimal solution to the specific case by analyzing more possible solutions from the point of energy and economy,
- work as a part of a team as well as demonstrate their entrepreneurial skills.

theoretical teaching

practical teaching


prerequisite

Defined in the Curriculum

learning resources

Benisek, M.: Lecture handouts (Hydro-mechanical plants, Hydro-mechanical equipment)
Bozic, I.: Auditory exercise handouts (Hydro-mechanical plants)
Božić, I.: Hydraulic Turbines - Practical examples with extracts from theory, University of Belgrade Faculty of Mechanical Engineering in Belgrade, 2017
Laboratory for hydraulic machines and energy systems - devices and installations.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 14
laboratory exercises: 0
calculation tasks: 8
seminar works: 0
project design: 6
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 6
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)
feedback during course study: 5

test/colloquium: 40

laboratory exercises: 0
calculation tasks: 0

seminar works: 0

project design: 25

final exam: 30

requirements to take the exam (number of points): 35

references

Бенишек, М.: Хидрауличне турбине, Машинас факултет у Београду, 1998
Иван О. Божић „Хидрауличне турбине - Практични примери са изводима из теорије“, Машинас факултет у Београду, 2017
IC Engine Design 2

ID: MSc-1089  
responsible/holder professor: Knežević M. Dragan  
teaching professor/s: Knežević M. Dragan  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written  
parent department: internal combustion engines  
semester.position: 3.1

goals

Torsional oscillations of the engine crankshaft. The formation of torsional oscillations, the risk of torsional oscillations, the ways of suppression of torsional oscillations, construction of torsional silencers.  
Specific design of two-stroke engines.

learning outcomes

Understanding the Design of complex machines and Devices. Recognition and understanding of the importance of subsystems for proper functioning of the system as whole.  
Understanding the design principles and role of Cooling System, Lubrication System and Starter System.  
Understanding of the torsion silencer construction.  
Capabilities to design and calculate vital components of IC Engine Auxiliary Systems.

theoretical teaching


practical teaching

Project Task: Design and calculation of Cooling/Lubricating System

prerequisite

Passed exam on course "IC Engines Processes"
learning resources

1. M.Tomić, M. Cvetić: Extracts from lectures (handouts) in digital form
2. D. Knežević: Extracts from lectures (handouts) in digital form
3. D. Knežević: Liquid & Air Cooling System Calculation Examples & Instructions in digital form

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 8
laboratory exercises: 0
calculation tasks: 8
seminar works: 0
project design: 10
consultations: 2
discussion and workshop: 2
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 8
colloquium, with assessment: 0
test, with assessment: 2
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 40
requirements to take the exam (number of points): 30

references
Launching Theory

ID: MSc-0195
responsible/holder professor: Milinović P. Momčilo
teaching professor/s: Milinović P. Momčilo
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 2
final exam: oral
parent department: weapon systems
semester.position: 3.1

goals

The basic purpose of the subject is aimed to the student knowledge and skills of applied launching ballistic mechanics, gas dynamics of missiles starting motion, on-in, the launcher, and relative interactive motions of combat platforms and launcher. The basic theoretical goal is to introduce students with simplified models of disturbances mechanics and to calculate critical disturbance cases and their influences on the launching and final missile shooting errors. Also, goals are to evaluate global design performances of launcher by functional and exploitation combat loads, as the input for strain and stress integration analyses.

learning outcomes

Student achieve capabilities for individual analyzes, preliminary integration and syntheses of launching mechanics applied on the launcher mounted on the combat platform of any type or design. Accepted methodology provides student ability to calculate and verify missile weapon efficiency, by recognizing loads and disturbances composed in the missile weapon errors, caused by tube, rail or container launcher type and their processes, integrated and jointed with the combat platforms, of any vehicle or vessel.

theoretical teaching

1. Launching mechanics and disturbances of the missiles and rockets from the rail type of launcher
2. launching mechanics of the tube launcher and forced gas generating motion and disturbances
3. Vertical platforms launching, open and tubes closed and their critical disturbances
4. Ripple rocket launching and combat and launching recoil and attack forces, and launcher and vehicle stability and disturbances.

practical teaching

1. Solution examples for low spin fin stabilized and high spin gyro stabilized unguided Rockets from the tube initial spin, and from the smooth barrel launchers.
2. Solutions of initial rocket flight and mathematical calculations of barrel length. Active flight calculations for unguided rockets.
3. Vertical launching errors and stability calculations. Zero initial velocity launchers
4. Loads and disturbances calculation on the missiles launching of guided flight

prerequisite

Finished and signed seminar paper.
learning resources

1. M. Milinovic: Basics of missiles and launchers design chapters from launcher design. Вучуревић, Основи пројектованја ракета и лансера, Масински Факултет Београд 2003. (serb), University of Belgrade Faculty of ME 2002., textbook
2. О. Vucurovic: Launchers design (serb), Belgrade University of Belgrade Faculty of ME 2002., monograph

number of hours

total number of hours: 30

active teaching (theoretical)

lectures: 12

active teaching (practical)

auditory exercises: 12
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 1
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
O. Vucurovic The basic of launchers design, Univers. of Belgrade, serb FME, Monograph, 2006.
M. Milinovic Launching theory, Univers. of Belgrade, engl, Univers. of Belgrade, FME, Layhandout, 2000.
Locomotive 2

**ID:** MSc-0230  
**responsible/holder professor:** Lučanin J. Vojkan  
**teaching professor/s:** Lučanin J. Vojkan, Tanasković D. Jovan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** railway mechanical engineering  
**semester.position:** 3.1

**goals**

1. Introduction student to the basic concepts important to understanding the designing of diesel-electric and electric locomotives.  
2. Knowledge acquiring necessary for understanding the designing of diesel-electric and electric locomotives.  
3. Competence for use the knowledge acquired in solving practical problems in designing, use and maintenance of diesel-electric and electric locomotives.

**learning outcomes**

After successfully finishing of course students would be able to:  
- define basic characteristics of diesel-electric and electric locomotives;  
- describe tasks and way of functioning of the main assemblies of diesel-electric and electric locomotives;  
- compare ways of functioning and control of electric drive motors for DC and AC power;  
- calculate the key tractive parameters using special software package;  
- implementation of regulations and standards in field of diesel-electric and electric locomotives.

**theoretical teaching**

Brief history, Overview of historical development and basic characteristic traction vehicles, High speed vehicles, Influential factors on adhesion, Traction force, Resistance during motion, Basic conception of diesel traction vehicles, Introductions with basic frame, Design of the bogie and the frame, Diesel motor - specification of diesel motors for railway vehicles, Power supply characteristics, Modern motors for railway vehicles, Examination and emission of exhaust gases, Characteristics of units for power transmission on railway vehicles, Design of mechanical gear, Design of hydrodynamic gear, Diesel motor and hydrodynamic gear working together, Design of cooling systems.

**practical teaching**

Practical training, Auditory exercises (Introductions with examples regarding learned materials - Modern solutions in the field of electric machines, Generators and Traction motors, Adjustments technique), Solving the set problem (Designing of diesel locomotives power supply systems), Introductions with practical problems in the field of inspection and maintenance of electric locomotives, Practical examples in the field of the electrical vehicles speed regulation - thyristors regulation, transducer. Visiting the maintenance shop for the electric locomotive. Exploring the traction vehicles components. Discussion and workshops.

**prerequisite**
Attended the course Locomotive 1.

**learning resources**

Syllabus, Guidebook for solving the tasks, Handouts, Personal PC, Projector and internet access - internet exploring for additional information's.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 0
calculation tasks: 5
seminar works: 0
project design: 0
consultations: 5
discussion and workshop: 5
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 5
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 10
seminar works: 15
project design: 0
final exam: 35
requirements to take the exam (number of points): 35

**references**

Zdravko Valter, Diesel - electric locomotive, Školska knjiga, Zagreb, 1985
Mechatronic robotics

ID: MSc-0827

responsible/holder professor: Lazarević P. Mihailo

Teaching professor/s: Lazarević P. Mihailo

Level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

Final exam: oral

Parent department: mechanics

Semester.position: 3.1

Goals

Introduce students to basic concepts of kinematics and dynamics of robotic systems. It is possible to solve direct and inverse kinematics and dynamics of the robot system (RS) using modern theory based on Rodriguez transformation matrix as well as the theory of finite rotations and quaternions. Determination (simulation) models of RS - i.e. differential equations of motion of the RS, which are important in practical problems of the RS. Practical simulations RS using Cyberbotics Webots software package and students work with laboratory robot NEUROARM. Introduce students to the basic control principles of the RS with regard to typical methods and control algorithms of RS.

Learning outcomes

• Determine the type of kinematic chain and the number of degrees of freedom of given robotic system (RS)
• Identify and calculate the matrix of transformation, using the orthogonal coordinate transformation and Rodrig transformation matrix, the theory of finite rotation and quaternions in the case of (Euler angles, Rezal angles, Hamilton-Rodrigues parameters, ...)
• Determine the analytical form basic kinematic characteristics of the RS with a large number of degrees of freedom using Rodrigues approach: characteristic position vectors of RS, speed and acceleration of the center of inertia of the robot segments (RSE), angular velocity and angular acceleration RSE, speed and acceleration of the robot gripper RS at the same time using computer tools (MATLAB, etc.)
• Forming a kinematic model RS with a large number of degrees of freedom in a matrix form and solve direct and inverse kinematics task of RS
• Determine the analytical form of generalized forces which acting on RS
• Forming the differential equations of motion for different cases of RS of topological structure applying Lagrange equations of second kind, the general laws of mechanics, D'Alembert's principle, Langrange-D'Alembert's principle, Žurden principle and the Gauss' principle
• Numerical simulate the previously formed differential equations of motion RS using suitable programming environment (MATLAB, Mathematica, etc.)
• Forming an appropriate RS model in a graphical environment -Cyberbotics Webots with simultaneous simulation of the same
• Compare the existing concepts of control mechanical systems and choose the appropriate concept of control for the considered RS.

Theoretical teaching

Basic concepts, definition of robot system (RS). Orthogonal transformation of coordinates. Rodriguez formula and the transformation matrix (MT), arbitrary and reference
configuration of RS. Complex MT of coordinates. Position vectors that define the configuration of the RS, internal and external coordinates of RS. Velocity and acceleration of the center of inertia of an arbitrary robot segment (RSE). Angular velocity and angular acceleration of an arbitrary RSE. Velocity of gripper tip of RS. Direct and inverse kinematics of robot task as well as singular cases. Constraints of RS. Momentum, angular momentum, kinetic energy of arbitrary robot segment of RS. Kinetic energy and the metric tensor of RS. Generalized forces and the principle of ideality RS-different cases. Differential equations (DIFE) of motion of RS. (DIFE) of motion of the RS in covariant form. Other methods of forming (DIFE) of motion of RS. DIFE of motion of RS given in the form of kinematic chain with the structure of topological three; DIFE of motion of RS given in the form of closed-kinematic chain. Additional equations of constraints. Constrained motion of robotic gripper. Equations of motion of RS with Langrange multipliers. Redundant RS. Basic concepts of control RS.

**practical teaching**

Examples of determining the number of degrees of motion of the RS; Calculation the transformation matrix (MT)- in case of Euler angles, and Hamilton-Rodriguez parameters; Determination of kinematic characteristics of the robot segment (RSE): angular velocity and angular acceleration RSE, velocity and acceleration of the observed point, RSE cases of Rezales and Euler angles. Application of Rodriguez transformation matrix, determine position vectors which define the configuration of the RS-in MATLAB environment. Kinematic characteristics of the i-th robot segment. Solving the direct and inverse kinematic task of RS. Determination of (planar) inertia tensor RSE, RS. Obtaining momentum and angular momentum, kinetic energy, the coefficient of the metric tensor RS, generalized forces, Christoffel symbols of the first kind. Solving the direct and inverse dynamics task of the RS. Examples of DIFE of RS simulation in MATLAB-GUI, MATHEMATICA environment, an example of a redundant RS. An example of simulation RS using Cyberbotics Webots package. Simulation examples of RS control using typical methods of control. One example of the control application on the existing laboratory NeuroArm robot with 7 degrees of freedom in the MATLAB environment.

**prerequisite**

desirable courses: Mechanics 1, Mechanics 2 Mechanics 3,

**learning resources**

1. Čović M. V. Lazarević, Mechanics of Robot, MF Belgrade, 2009. (Book)
2. Lazarević M. Exercises in mechanics of robot, MF Belgrade, 2006. (ZZD)
5. Written abstracts from the lectures, (Handouts)
6. Cyberbotics Webots - software package
8. MATLAB, MATHEMATICA-mathematics software packages

**number of hours**

total number of hours: 75
active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 6
calculation tasks: 5
seminar works: 0
project design: 6
consultations: 3
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 4
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 45
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 15
final exam: 30

requirements to take the exam (number of points): 35

references

Bruno Siciliano, Lorenzo Sciavicco Luigi Villani, Giuseppe Oriolo, Robotics: Modelling, Planning and Control, 2009 Springer-Verlag London
Mining and Construction Machines

ID: MSc-0102
responsible/holder professor: Bošnjak M. Srdan
teaching professor/s: Bošnjak M. Srdan, Gnjatović B. Nebojša
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: material handling, construction and logistics
semester.position: 3.1

goals

Basic course goals (objectives): 1) introducing students with specificities of working process, design, modeling and calculation of basic (fundamental) subsystems of construction and mining machines and appliances, primarily machines for continuous excavation and machines for crushing and screening. 2) mastering practical skills which are necessary for design and calculation of construction and mining machines.

learning outcomes

By successfully completing this course the student should be able to competently assess the following problems:
• Choosing a proper design and calculating rotating supports and mechanisms of earthmoving machines’ revolving superstructures:
• Choosing a proper design and calculating basic parameters of the earthmoving machines’ movement mechanisms;
• Determining and adopting basic parameters of the bucket wheel excavators’ (BWE) and bucket chain excavators’ drive systems;
• Proper strength calculation of open-pit mining machines’ substructures using linear Finite Element Method (FEM);
• Coupling of experimental and analytical data with the goal of properly determining parameters of BWE static stability;
• Comparison of design approaches and calculation of basic parameters of jaw, conic, gyratory, roll crushers and impactors according to required degree of material fragmentation.

theoretical teaching


practical teaching

Calculation of working (excavating) equipment, operating modes, and power of mechanisms of excavators for continuous excavation. 3D modeling of characteristic subassemblies of excavators for continuous excavation. Calculation models of truss substructures of bucket wheel excavators. Computer simulations of external loads. Load cases. Stress – strain identification. Creation (Development) of technical drawings. Position determination,
selection and calculation of basic (main) parameters of stackers (spreaders). Calculation of basic technical (design) and technological parameters, power and strength of jaw and cone crushers and screens. Consultations.

**prerequisite**

Defined by the curriculum of the study program

**learning resources**

1. Srđan Bošnjak, Bucket Wheel Trenchers, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, 2001., 2. Srđan Bošnjak, Handouts, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, 2008., 3. Srđan Bošnjak, Mining and construction machines - Instructions for writing laboratory reports, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, 2008., Computers, Laboratory 459(516), 5. Software Mathlab, (Catia)

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 5
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 5
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 30
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references

Vinko Jeftić, Construction and Mining Machines, University of Niš, Faculty of Mechanical Engineering, Niš, 1993.
Nanotechnology

ID: MSc-0727
responsible/holder professor: Matija R. Lidija
teaching professor/s: Matija R. Lidija
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: control engineering
semester.position: 3.1

goals

Goal of this subject is for students to acquire knowledges of: electron tunnelling phenomena, molecular attractive and repulsive forces, nanomaterials, conversion and transport of energy on nanoscale level. Introduction of basic methods, techniques and devices for characterisation of nanomaterials: Scanning NanoProbe microscopy and spectroscopy. Nano electrochemical cell. Characterisation of conductive, magnetic and non-conductive materials: inorganic as well as biological. Nano films: characterisation and modification of sample surfaces by STM/AFM/MFM methods.

learning outcomes

Upon successful completion of this course, students will be able to:

• Distinguish between the basic components and principles of electron tunneling as well as the basic components and principles of attraction-repulsion effects
• Apply basic theoretical and experimental knowledge to analyze nano system
• Work on devices for characterization of nanomaterials, STM and AFM
• Carry out appropriate preparation of various samples for the scanning probe microscopy
• Performs characterization of materials at the nano level
• Apply acquired knowledge of software analysis of graphical and analytical data obtained by scanning probe microscopy

theoretical teaching


practical teaching

Practical lessons: Demonstratory practice from nanotechnology instrumentation.

**Prerequisite**

Enlisted in 2nd semester of Master studies. Recommended: Introduction to nanotechnology.

**Learning resources**

NanoLaboratory with Chemical vapor deposition device for making thin films, NanoProbe microscope with integrated STM/AFM/MFM, electrochemical cell and fluid cell.

**Number of hours**

Total number of hours: 75

**Active teaching (theoretical)**

Lectures: 30

**Active teaching (practical)**

Auditory exercises: 15
Laboratory exercises: 10
Calculation tasks: 0
Seminar works: 3
Project design: 0
Consultations: 2
Discussion and workshop: 0
Research: 0

**Knowledge checks**

Check and assessment of calculation tasks: 0
Check and assessment of lab reports: 0
Check and assessment of seminar works: 6
Check and assessment of projects: 0
Colloquium, with assessment: 6
Test, with assessment: 0
Final exam: 3

**Assessment of knowledge (maximum number of points - 100)**

Feedback during course study: 5
Test/colloquium: 45
Laboratory exercises: 0
Calculation tasks: 0
Seminar works: 15
project design: 0
final exam: 35
requirements to take the exam (number of points): 35

references

Hanson,G.W., Fundamentals of nanoelectronics, Prentice Hall, New Jersey, 2008
New Technologies

**ID:** MSc-0104  
**responsible/holder professor:** Puzović M. Radovan  
**teaching professor/s:** Puzović M. Radovan, Tanović M. Ljubodrag  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** production engineering  
**semester.position:** 3.1

**goals**

The aims of introducing new technologies to production are top quality products, low-cost and short-time manufacturing process. This course is intended for students of the Production Engineering Department. Students are familiarized with modern technologies that make possible to extend knowledge acquired in Manufacturing Technology and Production Technologies and Metrology.

**learning outcomes**

On successful completion of the course, students should be able to:
- Design technology for building complex machine parts from various materials (metal, metal powder, polymer, ceramic, stone, etc.).
- Design technology for manufacturing of cutting tools (powder metallurgy).
- Identify versatile specificities of plastic parts pressure casting tools, stamping tools for metal parts.
- Use some of the advanced software tools for simulations of the polymer material parts pressure casting process, along with analysis and presentation of experimentally obtained results.
- Draft a plastic parts pressure casting tool for a specified part.
- Apply some of the developed CAD/CAE/CAM software tools for modeling drafted polymer material parts pressure casting tools.

**theoretical teaching**

AN-1: Introduction to new technologies; AN-2: Contemporary tools and tool materials; AN-3: Technology of synthesis; AN-4: Finish cutting technologies; AN-5: Machining technology by abrasive suspension; AN-6: Technology of powder metallurgy; AN-7: Technology of polymer shaping; AN-8: Forging technology; AR-1: Consolidation of teaching contents through presentation of new technologies; AR-2: Survey of contemporary cutting tools and tool materials application; AR-3: Demonstration of technology of synthesis; AR-4: Consolidation of teaching contents related to finish cutting methods; AR-5: Giving instructions for the design of tools for building machine parts from plastic masses; AR-6: Giving instructions for forging tools design;

**practical teaching**

PP-1: Design of tools for building machine parts from plastic masses or forging tools design (students opt for the design of one of the offered tools); PL-1: Standard and special cutting tools (tool material, geometrical shapes of tools, tool assembly, and tool use); PL-2: Application of machining technology by abrasive suspension (demonstration on concrete examples); PL-3: Tools for building machine parts from plastic masses (components, molding
systems, assembly, exploitation characteristics; PL-4: Forging tools (components, casting
systems, assembly, exploitation characteristics).

**prerequisite**

Defined by the Study Program Curriculum

**learning resources**

1. Handouts (PDF files) (18.) /In Serbian/
2. Kalajdžić M., Manufacturing technology, FME, Belgrade, 2005 (18.2) /In Serbian/
3. Laboratory equipment (tools and machines) at IMT (18.12)
4. SAx software work station (CAD, CAM, CAE, CAPP,...), (CAX) (18.13)

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 12
calculation tasks: 0
seminar works: 0
project design: 18
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 4
check and assessment of seminar works: 0
check and assessment of projects: 2
colloquium, with assessment: 0
test, with assessment: 4
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 40
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 15
final exam: 30
requirements to take the exam (number of points): 40
references

Handouts (PDF files) (18.) /In Serbian/
Kalajdžić M., Manufacturing technology, FME, Belgrade, 2005 (18.2) /In Serbian/
Laboratory equipment (tools and machines) at IMT (18.12)
SAx software work station (CAD, CAM, CAE, CAPP,...), (CAX) (18.13)
Packaging Machines

ID: MSc-0231  
responsible/holder professor: Miladinović D. Ljubomir  
teaching professor/s: Miladinović D. Ljubomir  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: project design  
parent department: theory of mechanisms and machines  
semester.position: 3.1

goals

Getting started with the machines that achieve these technological solutions. Acquiring the necessary knowledge in the field of thermal processes that are necessary for certain types of packages. Introduction to various techniques for normal and sterile package closing.

learning outcomes

This course gives the knowledge necessary for the maintenance of various packaging machinery that can be found in food and other industries. It also gives the necessary knowledge to the investors that order and purchase packaging machines. Besides this, students get all the specific technological, process and design knowledge for projecting and design of packaging machines.

theoretical teaching

Worm dozers and scales for packaging machines - dependence of the worm shape and the structure and quality of dozed material will be defined. Special attention will be paid to scales. Packaging machines with extrusion tubes - specific packaging line in which the container is made of extruded plastic tubes. Packaging machines with a heat extraction vessel - the specific packaging line in which the vessel is made by shallow or deep extraction of plastic foil.

practical teaching


prerequisite

To attend classes of the subject Packaging machines, no condition is necessary.

learning resources
To successfully master this subject, it is necessary to use a textbook that is in preparation, instructions for preparation of seminar papers, handouts, Internet resources.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 18
calculation tasks: 0
seminar works: 5
project design: 0
consultations: 7
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 4
check and assessment of seminar works: 3
check and assessment of projects: 0
colloquium, with assessment: 3
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 20
laboratory exercises: 25
calculation tasks: 0
seminar works: 20
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**

Lj. Miladinovic, M. Stoimenov, A. Veg, "Packaging Machines", monography
Production and Operations Management 2

ID: MSc-0413
responsible/holder professor: Milanović D. Dragan
teaching professor/s: Milanović D. Dragan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: industrial engineering
semester.position: 3.1

goals

Studying the management process of business-production system in its interaction with the environment. Identification of problems in business-production systems and the process of solving them, with implementation procedure. Investigation and design of production macro and micro organizational structure. Management of business-production system and provision of all resources necessary for production normal operation.

learning outcomes

Upon the successful completion of this course, students should be able to:
- discuss the problems of business-production planning, organization and management,
- integrate subsystems into a functional whole,
- select the methods and techniques for problem solving,
- apply the methods and techniques for business-production problem solving,
- solve the problems of business-production management,
- evaluate and cooperate in solution implementation.

theoretical teaching

Complex optimization of business-production systems in their interaction with the environment. Classification of business-production systems by the character of the technological process. Types of production organizational structure. Methods and techniques for scanning the current state of engineering-technological basics of production. Business-production problems and the process of solving them, with implementation procedure. Organizational structure of production and accessory units, operation and operational relations with organizational unit. Time management as an irretrievable resource, production cycle and delivery terms, flow coefficient, internal reserves and possibility of utilizing them. Design of macro, micro and intra organizational structure. Static and dynamic aspect with contents of jobs per organizational unit. Cybernetic model design for direct organization of production preparation and provision of all resources needed for normal operation of all work places. Methods and techniques of work place scanning.

practical teaching

Exercises are realized through project task in the enterprise. Project task should establish the most important organizational problems in an enterprise and propose how to solve them in order to improve organizational level in general and rationalize business operations and production. The design of jobs at work place is stressed. Job description, work conditions, job classification and work place matrix. Students are supposed to make concrete proposal for rationalization and improvement of operation of certain organizational wholes in business-
production system by applying contemporary methods and techniques of industrial management.

**prerequisite**

Production and Operations Management 1 (not obligatory); semester certified.

**learning resources**

The enterprise where the project is to be realized, so that students get familiarized with realistic conditions of production, scan the current state-of-art and collect documentation. The Chair allows students to use equipment for scanning work conditions at work place. Use of additional literature is recommendable, depending on the project theme.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 25
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 30
requirements to take the exam (number of points): 30
references

V. Bulat: Organization of production, FME, Belgrade, 1999 /In Serbian/
Ship design

ID: MSc-1018
responsible/holder professor: Kalajdžić D. Milan
teaching professor/s: Bačkalov A. Igor, Kalajdžić D. Milan, Momčilović V. Nikola, Motok D. Milorad, Simić P. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: naval systems
semester.position: 3.1

goals

To integrate the knowledge acquired from previous courses of naval architecture, and to develop knowledge and skills for the basic ship design.

learning outcomes

Ability to develop ship design, with the corresponding calculations, plans and technical documentation, for various ship types.

theoretical teaching


practical teaching

Practical problems of ship design, illustrating the subjects lectured in theoretical syllabus. In addition, students have to develop individually the project of a cargo ship (preliminary ship design of a container ship, bulk carrier, multipurpose ship or a tanker), with all the necessary calculations, plans (including the general arrangement) and the technical documentation.

prerequisite


learning resources

[1] I. Bačkalov: Extracts from lectures (handouts). /In Serbian/
[2] I. Bačkalov: Instructions for project design. /In Serbian/

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 5
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 25
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 10
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 40
final exam: 50
requirements to take the exam (number of points): 45

**references**

Structure Modelling with Calculation

ID: MSc-1098
responsible/holder professor: Marinković B. Aleksandar
teaching professor/s: Marinković B. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: general machine design
semester.position: 3.1

goals

The aim is to introduce students to the understanding of space and geometric forms in 3D environment. Intention is also understanding the topology types of machine parts, such as methodology of forming a 3D model as a starting point for the development of forms of machine parts and assemblies.

Machine components shape and dimensions determination used to be conducted based on previous knowledge and overpowered skills from Machine elements 1 and 2 courses. Learning and exercising of procedures and tools developed for manipulating forms and dimensions with parameter changes. Aim od this modification is to get an optimum shape that allow us to achieve optimal solutions in machine design modeling.

learning outcomes

Starting from basics in Machine elements, student used to define shape design of machine components concerning their dimensions and function. Taking into account other design criteria, student has skills to manage corresponding shapes of common machine components using CATIA software. It is completely trained to parametrically vary the shape and form parts, to optimize the form and combine them to compose the assembly. Student has acquired knowledge that the application of CATIA tool optimizes the shape and adjust the properties of this form. The student is also familiar with basics of using modules for simulation and structural analysis.

theoretical teaching


practical teaching

Introductory class. Training Concept with calculations and projects, Importance of dimensions calculation and function of machine components aime to define their proper shape. Calculation methods and determination of shafts and axles dimensions and shapes,
Calculation methods in determination sliding bearing, thread pairs, springs and other important machine components dimensions and shapes. Application of calculation results in shape design of machine components using CATIA V5 software tool.

The concept of using CATIA V5 software. The content of the program and the general settings of CATIA V5. Drawing projection and profile (Sketch). Body Modeling (Part Design), the basic principles and advanced commands. Shape modeling (Shape Design), it advantages and disadvantages. Defining relationships between the parameters of the modeled shape. Fundamentals of modeling assemblies (Assembly Design). Modeling circuits of varying complexity (Assembly Design). Obtaining drawings and preparation of technical documentation (drafting). Advanced tools and commands, special modules in CATIA V5. Introduction to analysis and simulation of components and assemblies.

**prerequisite**

Required: Attended and passed Engineering Graphics, Machine Elements 1 and Machine Elements 2
Preferred: Attended and passed Basics of Machine Design

**learning resources**

book "Shape Modeling" A.Marinković, M.Stanković, Mechanical Engineering Faculty 2011.; other literature for CATIA V5 software; hand-outs of lessons; equipment available in room 455, 3D printer and computers; CAD working station, CAD software tool CATIA V5.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 6
laboratory exercises: 0
calculation tasks: 4
seminar works: 0
project design: 10
consultations: 4
discussion and workshop: 4
research: 2

**knowledge checks**

check and assessment of calculation tasks: 4
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 1
test, with assessment: 1
final exam: 4

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0  
test/colloquium: 30  
laboratory exercises: 0  
calculation tasks: 20  
seminar works: 0  
project design: 20  
final exam: 30  
requirements to take the exam (number of points): 35

**references**

CATIA V5 documentation and tutorials for Shape Design and Structural Design modules  
Thermal Power Plants and Heat Plants

ID: MSc-1054
responsible/holder professor: Tucaković R. Dragan
teaching professor/s: Tucaković R. Dragan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: thermal science engineering
semester.position: 3.1

goals

Reaching the competence and academic skills and methods for it's acquiring. Developing creative capabilities and mastering the specific practical skills. Goals determine the specific results which should be achieved within the subject. Goals also represent basis for control of the achieved results. Activities in this subject are in accordance with basic tasks and goals of the study program.

learning outcomes

After successfully completing the course, the students will be able to:
• Acquire the essence of heat balance condensing thermal power plant.
• Be familiar with the regenerative heating feedwater schemes.
• Get to know about the water supply, transport fuels, slag and ash transport and flue gases depuration before its removal to the atmosphere.
• Get to know more about the principles of determining the location and general plan for thermal power plants and heating plants.
• Compare theoretical knowledge with plant derived from visiting a thermal power plant or heating plant.

theoretical teaching

Consumption of electrical and thermal energy; division of thermal power plants and technological scheme of thermal power plants; Efficiency and heat balance of condensation thermal power plant; Thermal efficiency and energy indicators of heating power stations; Steam parameters and reheating; Regenerative feed water heating; loss of steam, water and condensate and their fill; Power plant water supply; Transportation and storage of fuel in power plants; Transportation of slag and fly ash in thermal power plants; Filtration and drainage of flue gases into the atmosphere; Location and general plan for power plants;

practical teaching

Auditory exercises consist from demonstration exercises (Presentation and explanation of thermal power plant schemes; Representation and explanation of the power plant elements; Steam parameters of thermal power plants and reheating; Regenerative heating of condensate and feed water; The main operating facilities of domestic power plants; Displaying general plans for local power stations; Problems of exploitation of power plants); Instructions for making calculation task - Main features of the power plant block; Instructions for preparation of the paper - Elements of the power plant main facilities.

prerequisite

Faculty of Mechanical engineering — course catalog — M.Sc. (graduate) academic studies 542
Necessary condition: Bachelor's degree;
Preferred passed exam: Steam boilers elements and equipments and Steam boiler processing

learning resources

Books: Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers, Faculty of Mechanical Engineering, Belgrade, 2010, (In Serbian); Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers Thermal Calculation, Faculty of Mechanical Engineering, Belgrade, 2010, (In Serbian); handouts which will be at student's disposal a week in advance

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 6
laboratory exercises: 0
calculation tasks: 6
seminar works: 6
project design: 0
consultations: 2
discussion and workshop: 10
research: 0

knowledge checks

check and assessment of calculation tasks: 2
check and assessment of lab reports: 0
check and assessment of seminar works: 2
check and assessment of projects: 0
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 15
seminar works: 15
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

references
Lj. Brkic, T. Zivanovic, D. Tucakovic: Thermal Power Plants, Faculty of Mechanical Engineering, Belgrade, (In Serbian)
Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers, Faculty of Mechanical Engineering, Belgrade, (In Serbian)
Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers Thermal Calculation, Faculty of Mechanical Engineering, Belgrade, (In Serbian)
Vehicle body structure

ID: MSc-0441
responsible/holder professor: Rakićević B. Branislav
teaching professor/s: Mitić R. Saša, Rakićević B. Branislav
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: motor vehicles
semester.position: 3.1

goals

Aims of this course include achieving the competences to conquer specific knowledge and skills needed for overiewing and understanding problems related to construction, calculation, testing and verification of support structures of different categories of vehicles.

learning outcomes

After successful completion of this course, students should be trained to:
- Know and explain basic methods and procedures for vehicle’s body behaviour identification;
- List and explain characteristic calculation regimes specificities in body calculation;
- Recognize and explain the problems of thin-walled open cross-sections;
- Identify and interpret basic postulates of UN Regulations regarding the strength of bus superstructures;
- Analyze and explain basic problems of strength related to chassis – body interaction;
- Categorize different body types regarding their torsion stiffness and propose the application of appropriate elements for connection;
- Define all aspects needed for completion of commercial vehicles, taking into account related bodybuilder instructions.

theoretical teaching

(1) Introduction: Constructive concepts of superstructures in accordance with vehicle classification and categorization, characteristic solutions, basic instructions and recommendations; (2) Identification of superstructure behaviour, testing/calculation; methods, parameters and approval criteria; behaviour optimization, characteristic calculations modes; (3) Behaviour specificity of thin-walled open elements of SS; (4) Method of common constructive support surfaces, basic types of superstructures, ways and possibilities for implementation; (5) Finite elements method (FEM) in terms of methodological approach for identification of superstructure behaviour, basic characteristics and specificities; (6) Bus superstructures; specificities, strength of superstructures, domestic and international regulations; (7) Commercial vehicles superstructures; constructive and technological specificities of chassis of commercial vehicles, superstructures (different types, connection types for chassis and superstructure connecting, instructions and recommendations of chassis manufacturers), problems of vehicle completion (requests of valid standards and regulations, aspects of calculation, testing and verification); (8) Passenger vehicles superstructures; crash problems, values related to crashes, possibilities of modelling and experimental verification; (9) Regulations related to vehicle behaviour during crash (UN Regulations, EURO NCAP tests), characteristic parameters and criteria.

practical teaching
(1) Review of characteristic examples of passenger vehicles superstructures; (2) Review of specificities of superstructures for different bus categories (low-floor city bus, high floor touristic bus...); (3) Review and comments on chassis examples for commercial vehicles, as well as instructions and recommendations of manufacturers for superstructure mounting; (4) Examples of implementation of analytical approach in chassis calculation (ladder-type chassis); (5) Review of problems in calculation using FEM for particularly characteristic examples; (6) Bus superstructures; valid regulations (UN Regulations), requests related to passive safety (UN Regulation No. 66, review, comments and ways for fulfilling all requirements); (7) Individual student thesis related to bus superstructures; (8) Commercial vehicles superstructures; valid regulations (UN Regulations), requests related to passive safety (UN Regulation No. 58, 73,...); (9) Review of construction of some specific superstructures, explanations for different types of connections between chassis and superstructure and their implementation in process of vehicle completing; (10) Comments for possibilities to special purpose vehicles realization and explanations for implementation of instructions and recommendations of chassis manufacturers; procedures for defining the relevant safety and technical characteristics of completed vehicles; (11) Individual student thesis related to special purpose commercial vehicles (different superstructures); (12) Passenger vehicles superstructures; regulations related to vehicle behaviour during crash (UN Regulations, EURO NCAP tests), comments related to characteristic examples.

**prerequisite**

No special requirements.

**learning resources**

1. N. Janicijevic, D. Jankovic, J. Todorovic: Design of Motor Vehicles, Faculty of Mechanical Engineering, Belgrade, 2000,
2. D. Jankovic, N. Janicijevic: Coupling Road Vehicles and Special Devices: Theory – Design – Calculation – Standards, Faculty of Mechanical Engineering, Belgrade, 1985,
3. D. Jankovic, J. Todorovic, G. Ivanovic, B. Rakicevic: Theory of Vehicle Motion, Faculty of Mechanical Engineering, Belgrade, 2001,
4. Handouts,
5. Laboratory for Motor Vehicles, Institute for Motor Vehicles,
6. Laboratory CIAH, Institute for Motor Vehicles,
7. National and international standards, UN Regulations, EC Directives, related to motor vehicles
8. Technical documentation from leading world manufacturers (Volvo, Mercedes, Iveco, Renault, etc.) – Characteristics of vehicle chassis / guidelines and instructions for bodybuilders and vehicle completing.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 8
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 6
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 30
requirements to take the exam (number of points): 36

references

Tasko Maneski: Computer Modelling and structure calculation, Faculty of Mechanical Engineering, Belgrade, 1998.
Dobrosav Ruzic: Strength of Constructions, Faculty of Mechanical Engineering, Belgrade, 1995.
Welding technology

**ID:** MSc-0895  
**responsible/holder professor:** Sedmak S. Aleksandar  
**teaching professor/s:** Sedmak S. Aleksandar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** engineering materials and welding, tribology, fuels and combustion  
**semester.position:** 3.1

**goals**

Understanding the basic principles of welding technology as a prescribed course of action to be followed when making a weld. Introducing students to techniques of material selection, preparation, preheating, methods and control of welding and subsequent thermal treatment. Understanding and solving exercises in welding technology. Development of an independent paper by creation and presentation of selected seminar papers.

**learning outcomes**

By attending the course the students are mastering the basic knowledge of welding technology. Theoretical considerations and computational examples enable the student to master all the necessary principles of welding technology needed for the manufacture of welded joints. Introducing students to current modern standards and recommendations in this field.

**theoretical teaching**

Introduction to basic principles of welding technology. Defining the prior specification of welding technology (PSWT). Qualification of welding technology (QWT). Specification of welding technology (SWT) - analysis of the document defined by JUS EN 288-2 standard, containing information about the manufacturer, the basic material, process and welding position, joint preparation, notch and edges, welding technique, additional material, all welding parameters, preheating temperature and interlayer temperature. Heat treatment after welding. Welding sequence. Qualification of welders - analysis of EN 287-1 standard, which includes the principles on which the qualification testing of professional welders for welding steel by melting is based.

**practical teaching**

Auditory exercises with examples of welding technology problems. Solving exercises in specification of welding technology - examples include various types and thicknesses of the base metal, welding process and position. Solving exercises in qualification of welding technology - examples include various types and thicknesses of the base metal, welding process and position. The defense and presentation of selected seminar papers.

**prerequisite**

required: Mechanical Materials 1,2,3; Basic of Welding Process B (M)

**learning resources**
number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 15
laboratory exercises: 10
calculation tasks: 12
seminar works: 5
project design: 0
consultations: 4
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 1
check and assessment of lab reports: 0
check and assessment of seminar works: 1
check and assessment of projects: 0
colloquium, with assessment: 2
test, with assessment: 2
final exam: 3

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 25
laboratory exercises: 0
calculation tasks: 20
seminar works: 15
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references

[1] Written lessons from lectures (handouts)
[3] Excerpts from the standard
Aircraft propulsion

**ID:** MSc-0951  
**responsible/holder professor:** Fotev G. Vasko  
**teaching professor/s:** Simonović M. Aleksandar, Fotev G. Vasko  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** aerospace engineering  
**semester.position:** 3.2

**goals**

The main goal of the subject is to explain to the student the working principles, types, base elements, characteristics and working areas of air-breathing engines. All the time there is strong connections between types of engines and types of aircraft’s which combination graves best overall performances.

**learning outcomes**

The student gets ability to analyze and synthesize entity of flying vehicle and propulsor. The student gets knowledge of various types of air breathing engines, and their main energetic components. The student gets knowledge of engine performances, on which bases can have real proposition of the engine quality. Reached knowledge is good base for ongoing studies.

**theoretical teaching**


**practical teaching**

Practical part of the subject consists: working of numerical problems, solving of conceptual problems, discussions and explanations within presents of real engine cross section.

**prerequisite**

The student can apply this subject if has finished all obligatory duties which precede.

**learning resources**

Handouts, textbook, various tables needed for numerical examples, turbojet engine cross section.

**number of hours**

**total number of hours:** 75

**active teaching (theoretical)**
lectures: 30

**active teaching (practical)**

auditory exercises: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 10
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 20
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 50
requirements to take the exam (number of points): 50

**references**

Mechanics and Thermodynamics of Propulsion - Hill & Peterson 1992
Aerothermodynamics of Gas Turbine and Rocket Propulsion - G. Oates 1984
Aircraft engine design Mattingly 2002
Clinical Engineering

ID: MSc-0820
responsible/holder professor: Matija R. Lidija
teaching professor/s: Matija R. Lidija
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: control engineering
semester.position: 3.2

goals

To enable practical implementation, in real life clinical conditions, of theoretical knowledge and R&D results in the field of biomedical technology. To provide students with adequate medical knowledge to work in clinical environment. Enabling future clinical engineers to be a part of medical team and participate in every phase of clinical activities, such as: device initialization, adequate device application, device functions in vivo testing, monitoring of medical device or system performance, protection of patients and medical stuff from potential hazards in application of certain technologies, etc.
Introduction to design and maintenance of medical equipment (chirurgical tables, beds, chairs, etc.).

Give a history of medical devices and technologies development with respect to related branches of medicine. Getting to know medical reasons behind the development of certain devices. Overview of medical device classification based on the role they play in the hospitalization process. General introduction to medical device maintenance. Introduction to legislation regarding medical device design and maintenance. Basics of medical device design. Introduction to ARM microcontrollers for biomedical application. Making students capable to design medical devices based on STM 32, ARM, microcontrollers.

learning outcomes

Upon successful completion of this course, students will be able to:

• Apply gamma camera, PET and ultrasound in medicine
• Perform surface electrical stimulation of small intensity and activation of afferent system - artificial perception (in the laboratory)
• Perform measurements of evoked potentials induced by transcranial magnetic stimulation and measurement of temperature distribution (in the laboratory).
• Prepare all necessary documents for obtaining ethical permission for clinical work
• Prepare all necessary documents for obtaining a license to use a new instrument in the clinic.
• Distinguish and define the basic principles of diagnostic devices (biochemical analyzer - ECG - Rõ device)
• Develop applications for the STM32 microcontroller for adequately defined applications

theoretical teaching

Good practices regarding work in clinical environment. Ethics, standards and IT. Concept and basic characteristics of medical device. Medical device vs medical equipment. History of medical devices development. Connection between advances in science and development of biomedical apparatus. Medical device classification. Hospitalization and associated medical
Medical imaging – clinical applications (benefits, protection and potential hazards). DICOM standard. Electrical and magnetic stimulation - clinical applications; influence of electrical and magnetic field at a cellular level (benefits, protection and potential hazards). Clinical applications of laser.


Process and design stages of a medical device from an idea to a final product. Literature review: patent survey, marketing survey, setting up the requirements of the application, properties of the components of the device studied. Influence of regulatory aspects to medical device R&D chain. Setting up the schedule, work flow and budget for the project.

Introduction to microprocessors, microcontrollers and embedded systems. ARM microcontrollers architecture. Possible applications of microcontrollers in biomedical devices. Acquisition and processing of biomedical signals using microcontrollers and adequate peripherals. Microcontroller programming using C. Program debugging.

practical teaching

1. Preparation of material for obtaining ethical permission for clinical work and
2. Preparation of material for obtaining a license to use a new clinical equipment/device.

Basics of operation and maintenance of a variety of devices at the Institute for Cardiovascular Diseases "Dedinje":
Diagnostic devices:
- Biochemical analyzer
- ECG
- Rô aparatus
Medical intervention devices:
- An electro-scalpel
- Anesthesia machine
Devices for patient care:
- Respirator
- Monitor
- Syringe pump
Auxiliary devices, therapeutic devices and medical devices in general.
Application development for the STM32 microcontroller for the usage of triaxial accelerometer for acceleration monitoring of the individual body parts in various movements. Developing applications for the STM32 microcontroller for the usage of DS1820 temperature sensor for monitoring body temperature of a patient. Development of simple BAN (Body Area Network).

prerequisite

Attending requirements are defined by the curriculum of the study program/module.
learning resources

1. Written course material (handouts).
2. Printed manuals.
3. DAQ hardware.
4. Personal computers with installed data acquisition and processing software: LabView and MATLAB.
5. Four mikroACQ Kit 3 - STM32 ARM kits with adequate peripherals.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 15
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 5
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 3
final exam: 2

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 45
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 30
requirements to take the exam (number of points): 35

references
I. Hut, B. Jeftic: MATLAB and Microsoft Office for Engineers. (authorized material).
Computational Fluid Mechanics

**ID:** MSc-0939  
**responsible/holder professor:** Ćočić S. Aleksandar  
**teaching professor/s:** Ćočić S. Aleksandar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** fluid mechanics  
**semester.position:** 3.2

**goals**

Student should gain basic theoretical knowledge and principles of computational fluid dynamics (CFD), to be able to perform basic numerical calculations by using CFD methods, and to learn to use open-source CFD software OpenFOAM.

**learning outcomes**

Upon successful completion of the course, students will be able to:
- explain the general principles of numerical solution of governing equations for fluid flow
- explain and apply finite difference and finite volume methods for discretization of governing equations for fluid flow
- explain and apply principles of numerical grid generation
- use Python programming language for solution of modeled equation of fluid mechanics (1D and 2D heat equation, 1D wave equation, Burgers equation)
- use OpenFOAM solvers for determining the solution of 3D Laplace and convection-diffusion equation, and laminar incompressible flow in various domains
- explain general principles in turbulence modeling and apply turbulence models in OpenFOAM on specified cases of turbulent flow

**theoretical teaching**


**practical teaching**


**prerequisite**

Passed exams: Fluid Mechanics B and Numerical Methods, and Fluid Mechanics M (not obligatory, but it’s will be easier to follow the lectures).

**learning resources**

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 25

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 5
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 10
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 50
final exam: 40
requirements to take the exam (number of points): 0

references

Versteeg H., Malalasekera, An Introduction to Computational Fluid Dynamics - The Finite Volume Method, Pearson Prentice Hall
Control Systems Technology

ID: MSc-0118  
responsible/holder professor: Ribar B. Zoran  
teaching professor/s: Ribar B. Zoran  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: oral  
parent department: control engineering  
semester.position: 3.2

goals

-This subject introduce candidate with detailed characteristics of computer controlled systems. Also the candidate will be educated to implement knowledge to real computer controlled systems.  
-Candidate will be familiar with some methodologies for selection of computer components as well as other control components.  
-Candidate will be familiar with mentioned control systems.

learning outcomes

-To acquire basic knowledge from control systems theory and practice as well as other fields of applied sciences.  
-Introduction with methods for dynamic analysis and synthesis of control systems.  
-Methodology of analytical and/or experimental determination of static and dynamic characteristics of control systems.

theoretical teaching


practical teaching


Practice with pneumatic valves, electrohydraulic servovalves as well as electrohydraulic servosystems. Practice with industrial computers and networking.

prerequisite

Defined by curriculum of study program.
learning resources

- Control systems technology hands-out on: http://au.mas.bg.ac.yu/Nastava-Kau/Nastava_Download.html

- Electrohydraulic servosystem, Control systems laboratory.

- Electropneumatic servosystem, Control systems laboratory.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 15
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 4
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references
Cranes Design

**ID:** MSc-0139  
**responsible/holder professor:** Zrnić Đ. Nenad  
**teaching professor/s:** Zrnić Đ. Nenad  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** material handling, construction and logistics  
**semester.position:** 3.2

**goals**

The main objective of this course is to achieve competence of students to master the principles of cranes design and that is able to be incorporated into the cranes design process in the future engineering work. The goal is to master specific practical skills for the selection of drive units, calculation of support steel structures of cranes and to get the knowledge on the standards for calculation, as well as realization of technical documentations.

**learning outcomes**

Upon successful completion of this course, students should be able to:  
- identify, classify and analyze regular, occasional and exceptional load at overhead travelling cranes  
- perform calculation and selection of the bridge crane geometry  
- determine the load of the bridge crane in characteristic cross section  
- perform proof of stress, proof of deformation, proof of dynamic stiffness, proof of elastic stability, proof of bolted connection between the main girders and end carriages  
- perform calculation and choose stiffnesses  
- perform calculation of end carriages  
- carry out the verification of the analytical calculation with the results obtained in the FEM software package

**theoretical teaching**

The basic principles of cranes design, trends in development, maintenance, transportation and crane installation, testing and registration of cranes, safety measures. Standards for calculation of support structures of cranes, trolley selection, sizing and calculation of trolley supporting structure and its drive. Calculation of support structure of bridge cranes, the selection of geometry of main girders and end carriages, proof of stress, proof of deformation, proof of dynamic stiffness, loads of main girder, proof of welded connections. Elastic stability of girder, local stability of plate, calculation of the connections of main girders and end carriages, calculation of end carriage, specificities in calculation of the single girder bridge cranes.

**practical teaching**

Realization of the project of double girder crane, selection of drive units, selection of geometry and calculation of support structures of trolley and crane, proof of elastic stability - buckling of plates, calculation of single girder bridge cranes. Computer exercises, calculation of supporting structure of bridge cranes by using FEM, with training in the use and application of specialized software package KRASTA (Cranes Statik, non-commercial...
academic version without restrictions concerning calculations), for static and dynamic analysis of supporting structures of material handling and conveying machines by using finite elements method.

**prerequisite**

The conditions are defined by the curriculum of the study program.

**learning resources**

1. Nenad Zrnic: handouts - Written lectures, 2011, DVL
2. Slobodan Tosic, D. Ostric: Cranes, Faculty of Mechanical Engineering, 2005, KDA.
3. KRASTA - Program for statical and modal analysis of spatial frames, MANUAL, DVL.
4. Computers, Laboratory 516, ICT / CAH
5. KRASTA software package - program for statical and modal analysis of spatial frames, BSB Kühne GmbH, ICT / CSP

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 15
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 5
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 40
final exam: 30
requirements to take the exam (number of points): 35

references
Design and Exploitation of Thermal Power Plants

ID: MSc-0913
responsible/holder professor: Petrović V. Milan
teaching professor/s: Banjac B. Milan, Petrović V. Milan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: thermal power engineering
semester.position: 3.2

goals

The aim of the course is to provide a knowledge base in the field of planning, design, contracting, acceptance tests, operation and maintenance of thermal power plants. Exercise program consists of making of a shortened power plant conceptual design based on the implementation of certain acquired practical knowledge of the course program.

learning outcomes

On completion of this programme, it is expected that student will be able to:
• make preliminary design of the thermal power plant with steam and gas turbines,
• analyze and choose the location for the construction of thermal power plants,
• choose the most suitable thermal power technology for a given type of use,
• perform calculation of the working conditions and capacity of individual system and components of the thermal power plants
• define the concept and disposition projected plants
• carry out measurements of the most important operating parameters (pressure, temperature and flow) on the steam turbine plant
• conduct tests of steam turbine plant to determine the thermal efficiency of the steam turbine plan as well as the efficiency of the steam turbine,
• analyze test data of steam turbine plant and apply the appropriate correction to translate the real working conditions to the design conditions,
• calculate production price of electricity and heat in combined energy production and economic feasibility parameters determine.

theoretical teaching

The main phases of the design of thermal power plants. Criteria for selection of the type and location of the power plant. The content of the preliminary design to the investment program. The general layout and composition of the thermal power plant. Guidelines for contracting and procurement of equipment of thermal power plants. Acceptance and operational testing of the thermal power plant. Behavior of the thermal power plants in operation: start and stop modes. Maintenance and monitoring of the thermal power plants operating conditions: maintaining the protection and regulation, monitoring of the turbine, the turbine deposition and their removal, the importance of maintaining the quality of the water regime, condensing plants, regenerative heating system of main condensate and feedwater, turbine sealing system, etc. The importance of following of diagnostic operating conditions, cost control and the functional readiness of the power plant. Reliability and availability of power plant.

practical teaching
Making of a conceptual design of a power plant: selection of the power plants micro location, general concepts, choice disposition of all power plant parts, analysis of selection schemes and thermal parameters. The main mechanical unit: an analysis of selection schemes and thermal parameters, the choice of boiler, selection of steam turbine plants. Calculation task consists in the development of computer programs for calculating the impact parameter deviations live steam on the cost of the steam turbine plant.

**prerequisite**

Course in Steam Turbines

**learning resources**

Written manuscript.
2. Rižkin, V.: Thermal power Plants Energoatomizdat, Moskva, 1987.-KSJ

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 6
laboratory exercises: 0
calculation tasks: 4
seminar works: 0
project design: 20
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 3
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 2
final exam: 5
assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 10
seminar works: 0
project design: 30
final exam: 30
requirements to take the exam (number of points): 30

references

Design of missiles and launchers

**ID:** MSc-1012  
**responsible/holder professor:** Milinović P. Momčilo  
**teaching professor/s:** Milinović P. Momčilo  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** weapon systems  
**semester.position:** 3.2

**goals**

Goal of subject is to achieve student in detail contents of missiles subsystems its integration and key performances of flight and terminal phase, functions. Goal of knowledge’s are directed on the technology roll and influences on the particular quality and quantity of missiles performances. Missile is considered as the flight vehicle and ammunition for the different payload purposes and defense missions. Student developing detailed skills and knowledge for design, analyzes, syntheses of missiles and rockets and about its advanced technology applications on the component design its research and methodology of calculations and development.

Goal of subject is to achieve student knowledge in two basic launcher equipment Sub systems. Sub systems of equipment and devices for shooting and missiles positioning and launching, and subsystems of equipment and devices for other defense and military integrated functions available on the self-propelled weapon launcher. Student through practical project research of concept and component integration realize knowledge of software and hardware integration on the launcher and new technologies implementation on the self propelled or portable weapon missile launching Systems.

**learning outcomes**

Student achieve level of individual designer of tactical missiles and other jobs and purposes of missile syntheses. Also, student is accomplished for the analyzes and syntheses of all levels and types in the missile and ammunition rocket technologies by tools of applied mechanics and software analyzes of integrative rocket and missile technologies and performances. Parametric composition of missile flight mechanics, special ballistics and rocket propulsion propellants performances and other interdisciplinary integration selection and estimations, is comprehension output of subject.

Student realizes skills and knowledge for individual integrating of launcher weapon, their conceptual solutions and critical thinking and opinion about advantages for applied Systems and sub systems. Also launcher and its equipment is integrative design system test for knowledge of missile system design and defense functions. Student through practical selections of functions and its solutions gets knowledge of compromises in technology possibilities and threshold performances of practical use and its requirements.

**theoretical teaching**

1. Missiles and rockets as the ammunition or as the combat flight platform  
2. Mass model, ranges and performances, defense performances of different missile types  
3. Flight aerodynamics, stabilization and control of missiles and component performances, unguided fin, low spin and high spin stabilization.
4. Disposition missile design, Cases of missiles loading forces and moments, strain and stresses of missiles design.
5. Missile Propulsion system integration and optimization and thrust vector control.
6. Content of subsystems for MLRS, AT, AD, BM, launchers mechanisms integrated for missiles launching, and shooting, devices functional and equipment design.
7. Equipment for launching stability, energy supply and other conditions for functional and environmental uses of defense and functional missiles weapon technology.

**practical teaching**

1. Payload design preliminary solution
2. Missiles projectiles preliminary design guided and unguided
3. Concept of missile tactical mission, preliminary design of requirements and performances
4. Seminar case study of missile or rocket preliminary design for new missile of chosen mission, presentation of solution.
5. Critical technology in project designs a consulting for solutions optimization.

Conditions for attend
Welcome, presence or distance contact,
Project design obligation
6. Mass model of self propelled launcher of missiles. Principal solutions, and design art. Functional and defense properties capacities of launching and weapon performances of principal solutions
7. Kinematics and dynamics of launching mechanisms in joint work with system integration concept, elevation mechanism, stabilization mech. direction mechan., fire mech. and launching forces estimation.
8. Presentation of joint launcher project and its substitution with critical estimations of components, and technology.

**prerequisite**

Project design - finished hard copy

**learning resources**

1. M. Milinovic: Basics of missiles and launchers design (serb), University of Belgrade Faculty of ME 2002., textbook
2. M. Milinovic - Basics of missiles launchers design (eng.), University of Belgrade Faculty of ME 2000., layhandout
3. M. Milinovic, M. Holclajtner - Basics of missiles design (serb), University of Belgrade Faculty of ME 2004., layhandout
4. M. Milinovic: Basics of missiles and launchers design (serb), University of Belgrade Faculty of ME 2002., textbook
5. O. Vucurovic: Launchers design (serb), Belgrade University of Belgrade Faculty of ME 2002., monograph

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30
active teaching (practical)

auditory exercises: 16
laboratory exercises: 5
calculation tasks: 4
seminar works: 0
project design: 5
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 4
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 30
requirements to take the exam (number of points): 35

references

M. Milinovic: Basics of missiles and launchers design (serb), University of Belgrade Faculty of ME 2002., textbook
M. Milinovic - Basics of missiles launchers design (eng.), University of Belgrade Faculty of ME 2000., layhandout
O. Vucurovic: Launchers design (serb), Belgrade University of Belgrade Faculty of ME 2002., monograph
Food Processing Machines

**ID:** MSc-1175  
**responsible/holder professor:** Jeli V. Zorana  
**teaching professor/s:** Jeli V. Zorana, Petrović V. Dragan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** theory of mechanisms and machines  
**semester.position:** 3.2

**goals**

1. Getting acquainted with the basic concepts necessary for dealing with matter in this field.  
2. Acquiring skills in preparation of modern design programs for designing and analyzing the operation of food equipment and plants.  
3. Developing students’ creative abilities to design food systems, machines and systems.

**learning outcomes**

1. Knowledge and understanding of the problem of food machines  
2. Analyzing existing solutions and their effects  
3. Linking knowledge from various fields of technology, tracking the newspapers and applying them  
4. Adopting practical knowledge  
5. Solving concrete problems in the production of food machines.

**theoretical teaching**

Acquiring knowledge about food products in general and their classification, understanding of basic technological requirements and ways of their realization, grain processing machinery, constructive characteristics and examination of various types of mills as characteristic machines in the field of grain processing, machinery in the confectionery industry, overview of characteristic types of machines for different types of confectionery products, their working principles and technical characteristics, transport systems in the confectionery industry, connection of individual machines in these cation of the parent entity for the production of confectionery products, automated production lines for hard biscuits and crackers, the characteristics of machines for test preparation, test processing and obtaining the final form pasta making machines for fruit and vegetable processing, milk processing machinery, machinery for meat processing.

**practical teaching**

Practical exercises which include familiarization with the basic technical and technological characteristics of typical representatives of food processing machines for grain processing (mills and sieves), machinery in the baking industry (mixers, dividers, fermentation chambers, formations), machine in the confectionery industry (laminating machines, shaping, cutting), a fruit and vegetable processing machine, a milk processing machine and a meat processing machine. Preparation of a project which includes defining the project task, the necessary calculations and the production of documentation of assemblies or complete devices.

**prerequisite**

There are no special conditions for attending the course, preferably listened to and passed.
Basic Technological Operations in Food Engineering.

**learning resources**

Скрипта у припреми. За успешно савладавање предмета неопходно је коришћење упутства за израду пројеката, handout-a, Ineternet ресурса и видео записа.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 8
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
consultations: 2
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 6
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 40
final exam: 30
requirements to take the exam (number of points): 44

**references**
Heat Pumps

**ID:** MSc-1120  
**responsible/holder professor:** Milovančević M. Uroš  
**teaching professor/s:** Milovančević M. Uroš  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** thermal science engineering  
**semester.position:** 3.2

**goals**

Achieving of competence and academic skills as well as methods for their acquisition. The development of creative abilities and practical skills which are essential to the profession. Objectives are concrete and achievable and in full accordance with the defined basic tasks and objectives of the study program.

**learning outcomes**

Student acquires subject-specific abilities that are essential for the quality of professional activities: analysis, synthesis and prediction of solutions and consequences; application of knowledge in practice; linking the basic knowledge in various fields with their application to solve specific problems.

**theoretical teaching**

Characteristics of heat pumps: Systematization of thermal systems performing refrigeration cycles, The criteria for evaluation of thermodynamic quality of refrigeration cycles, Heat sources for heat pumps, (atmospheric air, surface water, groundwater and soil, geothermal energy, heat accumulators, solar plate collectors), Thermodynamic improvement of refrigeration cycles; Sorption refrigeration systems; Properties of refrigerant-absorbent mixtures: Basic steady-flow processes with binary mixtures; Basic vapour absorption refrigeration system, (VARS), Steady-flow analysis of the VARS, Maximum COP of ideal absorption refrigeration system, Comparison between compression and absorption refrigeration systems.

**practical teaching**

Auditory training: systematization of thermal systems performing refrigeration cycles, predicting of heat pumps performances, mass and heat balance of drying processing, determination of characteristics of the heat pump elements, (compressor, condenser, evaporator), binary mixtures, the basic operations with binary mixtures, thermodynamic calculation of single effect VARS  
Laboratory exercise: demonstration of heat pumps for air conditioning system of a hotel building;  
Design project of heat pump system: work in groups of 5 students (for a particular object and refrigerant), calculation and selection of elements of heat pump,
Analysis of complete vapour compression heat pump plant.

**prerequisite**

Necessary passed the test: Refrigeration Equipment, Refrigeration Systems

**learning resources**

1. Textbook: M. Markoski: Refrigeration, Mechanical Engineering, 2006,
2. Handouts which are available in advance for each week of classes

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 15
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 50
requirements to take the exam (number of points): 21

**references**
Hydraulic power transmitters

ID: MSc-1002
responsible/holder professor: Čantrak S. Đorđe
teaching professor/s: Čantrak S. Đorđe
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: hydropower engineering
semester.position: 3.2

goals

Theory and practical skills about hydraulic power transmission, with focus on hydrodynamic power transmission. Selection and application of hydraulic transmission.

learning outcomes

Upon successful completion of this course, students should be able to:
1. identify and describe the various types and constructions of the hydraulic power transmission systems (hydraulic torque converter, hydraulic coupling and brake), and the principles of their work,
2. select the appropriate hydraulic power transmission system,
3. examine the hydraulic power transmission system according to the valid international standard.

theoretical teaching


practical teaching

Laboratory: Constructions of the hydrodynamic couplings.
Seminary work: Presentation of the work on the task topic.

prerequisite
Compulsory: Fluid Mechanics B.

learning resources

Literature listed in references, lectures in hard copy and electronic form, exercises in hard copy.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 13
laboratory exercises: 1
calculation tasks: 2
seminar works: 4
project design: 5
consultations: 3
discussion and workshop: 2
research: 0

knowledge checks

check and assessment of calculation tasks: 2
check and assessment of lab reports: 0
check and assessment of seminar works: 2
check and assessment of projects: 4
colloquium, with assessment: 2
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 10
laboratory exercises: 0
calculation tasks: 10
seminar works: 10
project design: 30
final exam: 30
requirements to take the exam (number of points): 30

references
IC Engine Testing

ID: MSc-0860
responsible/holder professor: Miljić L. Nenad
teaching professor/s: Miljić L. Nenad
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: internal combustion engines
semester.position: 3.2

goals

To cover the basic knowledge of experimental work in the field of IC Engines. Broadening of measuring techniques knowledge, used in engineering, through acquaintance with specific measuring equipment, devices and software tools used for IC engine testing. Developing of skills required for developing of IC engines test facilities, choice of adequate measuring equipment, devices and auxiliaries for funding IC engine test bench. Developing of skills required for planning, organization and conducting an IC Engine testing.

learning outcomes

Practical knowledge in IC engine testing procedures, operations and data analysis. Ability in solving and analysis of practical engineering tasks related to IC engine testing and IC engine test measuring equipment and facilities

theoretical teaching

Measurement of: Torques and forces; rotational speed and acceleration; gas and fuel mass and volumetric flow (with anemometry); temperatures and pressures; IC engine indicating techniques and measurement equipment; IC Engine exhaust analysis; Engine dynamometers; Fundamentals of IC Engines test benches design; IC engine testing standards, procedures and operations

practical teaching

Measurement errors and uncertainty (examples with calculation tasks); Introduction to Labview (NI) measurement and programming environment; Calibration of measurement chains; Preparation for laboratory tasks (description of measuring equipment and chains used, task instructions):

Getting acquaintance with the Labview environment and its usage in IC engine testing tasks; Calibration of specific transducer measurement chain (torque, pressure, temperature,...); IC Engine in cylinder pressure indicating; Measurements on engine test bench - gathering data for BSFC characteristics map; Determining the energy balance of an ICE

prerequisite

Passed exam on course “IC engine working processes”

learning resources

-Živković, M.C, Trifunović, R.: IC Engine Testing (on Serbian), FME Belgrade
- Lecture Handouts, Lab Exercises Instructions, Calculus examples (pdf)
- Laboratories equipped with IC Engine testing equipment (fully equipped IC Engine test benches)
- DAQ Measurement equipment (National Instruments PXI based system with Labview Development software)

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 12
laboratory exercises: 14
calculation tasks: 4
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 2
check and assessment of lab reports: 6
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 2
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 20
laboratory exercises: 30
calculation tasks: 10
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

**references**
Managing food safety and quality

**ID:** MSc-0596  
**responsible/holder professor:** Marković D. Dragan  
**teaching professor/s:** Marković D. Dragan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** agricultural engineering  
**semester.position:** 3.2

### goals

1. The subject should enable students to acquire knowledge about the concept of certification and its importance for the market, environmental protection and good agricultural practice, the function of certification.
2. Introduction to basic procedures for certification, certification course, participants, their rights and obligations, the general principles of all standards relating to food and industrial processing of food products and exposure with institutions and organizations dealing with food safety in Serbia and abroad.
3. The subject should enable students to acquire knowledge / understanding of contemporary approaches and principles of quality management, quality management functions of the organization, specific methods of management and quality control, new business strategies, new systems and specific quality management activities.
4. Learning about new trends in food production.

### learning outcomes

After successfully completing of this course, students should be able to:

1. Define the basic concepts related to standardization and regulations in the production and processing of food
2. Formulate and improve the application of modern quality management system
3. Analyzing the role of certification and its role in the food market, environmental protection and good agricultural practices
4. Preparations risk analysis
5. Applying appropriate standards.

### theoretical teaching


### practical teaching

Practical teaching coupled with interactive lessons take place in the field of modern quality management system operations, the food industry and safety management and quality of products (food). The way the accreditation of laboratories and the introduction of standards in the control of production flows. Planned are two tests and essay.

### prerequisite
Attended courses of previous years of study and all the conditions defined curriculum of study program / module

**learning resources**

2. Djekic, I., (2009) Environmental management in food production. University of Belgrade, Faculty of Agriculture

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 4
check and assessment of projects: 0
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 0
calculation tasks: 0
seminar works: 20
project design: 0
final exam: 30
requirements to take the exam (number of points): 50

**references**
Grujic, R., Radovanovic, R. (2007): Quality management and safety in food production. University of Banja Luka, Faculty of Technology (RS / BiH)
Djekic, I., (2009) Environmental management in food production. University of Belgrade, Faculty of Agriculture
Grujic, R. et al. : Quality and Food Analysis, Faculty of Technology in Banja Luka, RS / BiH. 2001
Mass transfer operations and equipment

ID: MSc-1060
responsible/holder professor: Genić B. Srbislav

level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: process and environmental protection engineering

goals
Analysis of the mass transfer operations and apparatuses and assessment of their role in modern industry.
Understanding the most commonly used types of mass transfer apparatuses - their design and calculation procedures.

learning outcomes
The mastery of calculation procedures needed to analyze the mass transfer operations - the material balance, determination of the operational line and driving force.
The mastery of calculation procedures for sizing of the most commonly used mass transfer apparatuses.

theoretical teaching
Classification of mass transfer operations and basics principles of mass-transfer operations
General calculation procedure for mass transfer operations. Operation and equilibrium line, mass transfer driving force, number of transfer units, theoretical stage.
Mass transfer operations: distillation (continuous evaporation, single stage distillation, continuous condensation, distillation with deflegmation, differential distillation, fractional distillation, differential condensation), rectification, absorption, extraction, leaching, adsorption, drying.
Mass transfer apparatuses for gas-liquid systems, liquid-liquid and solid phase - fluid. Trayed and packed columns, drying chambers, etc.
Membrane mass transfer operations and apparatuses.
Development trends in the field of mass transfer operations and apparatuses.

practical teaching
Examples of mass transfer operations. Mass and heat balancing. Determination of the operating line, driving force, the number of transfer units, the number of theoretical stages.
Examples of sizing of most commonly used mass transfer apparatuses: distillation column (with packing and with trays), extraction columns (with packing and with trays), adsorber (with a fixed layer of adsorbent), dryers (continuous and periodical).
Design procedures for membrane mass transfer operations and apparatuses.

prerequisite
Defined in curriculum of the study program of the module.

learning resources
number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 15

active teaching (practical)

auditory exercises: 13
laboratory exercises: 2
calculation tasks: 10
seminar works: 0
project design: 10
consultations: 6
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 5
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 4
final exam: 3

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 60
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 0

references
Methods of Optimization

ID: MSc-0485  
responsible/holder professor: Rosić B. Božidar  
teaching professor/s: Rosić B. Božidar  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written  
parent department: information technologies  
semester.position: 3.2

goals

The main goal of this course for the student is to give the necessary knowledge of:
• numerical analysis and optimization,
• understanding general principles of design optimization
• formulating the optimization problems and identify critical elements.

learning outcomes

After completing this course students are able to successfully apply the acquired theoretical and practical knowledge and are able to:
•Identify relevant optimization variables, define the set of functional constraints and limitations for the corresponding optimization model of a given mechanical system.
•Apply linear and non-linear numerical methods for solving the optimization problems and define the appropriate convergence criteria.
•Develop and implement computer programs in software packages Python / MATLAB for solving the set of optimization tasks.
•Analyze the results and check the validity of the proposed optimization models with respect to the change of input parameters.
•Apply the stochastic - heuristic methods and develop hybridized heuristic methods to determine the global solution of the optimization problems of complex mechanical systems.
•Develop new and apply existing numerical methods for solving complex optimization tasks, individually or as part of an appropriate team.

theoretical teaching

A general mathematical model for optimization.  
optimization toolbox.

practical teaching

Consists of the auditory and laboratory exercises. Projects are main component of this course.

prerequisite

Knowledge of linear algebra and numerical mathematics. Computer programming in MATLAB. Some knowledge of basic machine elements and mechanics.

learning resources

Computer Usage: Students extensively use the computer and optimization toolbox using MATLAB program. Handout.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 6 laboratory exercises: 21 calculation tasks: 0 seminar works: 7
project design: 3
consultations: 0
discussion and workshop: 3
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 7
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 3
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 35
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

**references**

Methods of Optimization

ID: MSc-0485
responsible/holder professor: Rosić B. Božidar
teaching professor/s: Rosić B. Božidar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: information technologies
semester.position: 3.2

goals

The main goal of this course for the student is to give the necessary knowledge of:
- numerical analysis and optimization,
- understanding general principles of design optimization
- formulating the optimization problems and identify critical elements.

learning outcomes

After completing this course students are able to successfully apply the acquired theoretical and practical knowledge and are able to:
- Identify relevant optimization variables, define the set of functional constraints and limitations for the corresponding optimization model of a given mechanical system.
- Apply linear and non-linear numerical methods for solving the optimization problems and define the appropriate convergence criteria.
- Develop and implement computer programs in software packages Python / MATLAB for solving the set of optimization tasks.
- Analyze the results and check the validity of the proposed optimization models with respect to the change of input parameters.
- Apply the stochastic - heuristic methods and develop hybridized heuristic methods to determine the global solution of the optimization problems of complex mechanical systems.
- Develop new and apply existing numerical methods for solving complex optimization tasks, individually or as part of an appropriate team.

theoretical teaching

   A general mathematical model for optimization.
optimization toolbox.

practical teaching

Consists of the auditory and laboratory exercises. Projects are main component of this course.

prerequisite

Knowledge of linear algebra and numerical mathematics. Computer programming in MATLAB. Some knowledge of basic machine elements and mechanics.

learning resources

Computer Usage: Students extensively use the computer and optimization toolbox using MATLAB program. Handout.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 6
laboratory exercises: 21
calculation tasks: 0
seminar works: 7
project design: 3
consultations: 0
discussion and workshop: 3
research: 0

knowledge checks
check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 7
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 3
final exam: 5

assessment of knowledge (maximum number of points - 100)
feedback during course study: 5
test/colloquium: 35
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Organization Design

**ID:** MSc-0574  
**responsible/holder professor:** Spasojević-Brkić K. Vesna  
**teaching professor/s:** Spasojević-Brkić K. Vesna  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** industrial engineering  
**semester.position:** 3.2

**goals**

The aim of this course is to acquire the necessary knowledge and practical skills that will enable students to define the interdependence of the elements of organizational structure and processes so that in a given or anticipated situation organizationally shaped organizational system (enterprise or its parts) achieves the pursued objectives and goals.

**learning outcomes**

Through this course students acquire knowledge and skills in the fields of acquisition of theoretical and practical knowledge in the field of intentional and controlled development and changes in the organization to improve efficiency and effectiveness, and working conditions in the organization, alignment of organizational and technical / technological factors and changing of organizational culture and climate and setting the optimal model organization with respect to the objectives and available resources. By the end of the Organisation Design course student will be able to:
- tackle an organisation design project  
- sequence and approach the design effectively  
- apply various tools and techniques to make good organisation  
- design decisions  
- control the consequences and risks of design changes  
- recognize design project blockers and challenges and  
- address design project blockers and challenges.

**theoretical teaching**


**practical teaching**

macro and micro organizational structure of the company. Check the proposed solution of the organizational structure OrgCon software package.

prerequisite

Students need to enroll 9th semester.

learning resources

6. Handout

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 3
laboratory exercises: 0
calculation tasks: 6
seminar works: 0
project design: 20
consultations: 1
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 1
check and assessment of projects: 5
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 20
project design: 35
final exam: 35
requirements to take the exam (number of points): 30

references

Quality Management

**ID:** MSc-1167  
**responsible/holder professor:** Stojadinović M. Slavenko  
**teaching professor/s:** Stojadinović M. Slavenko  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** production engineering  
**semester.position:** 3.2

**goals**

The objective of this course is to acquire knowledge and skills necessary for solving theoretical and practical problems in the field of quality management of products and services, that are necessary for successful further scientific-professional work of students and engineers. Students should: to master the basic terms, the definition of quality and the development of systematic approaches to improving quality; to get familiar with analytical methods of quality management and quality engineering techniques; acquire knowledge from statistical methods of quality management; acquire skills from experimental methods of quality management; to get familiar with the quality standards, requirements and the implementation of the ISO 9001 series.

**learning outcomes**

After successfully completion of this course, the students should be capable to: determine and define the scope of quality management in an industrial environment; classify, rank, analyze and evaluate the importance of quality characteristics; calculate the partial and total processing error for a particular technology and processing conditions and analyze the accuracy of the process; design and application of statistical quality engineering techniques for concretely production conditions: get static sheet, control card and acceptance plan; generate a measurement protocol on a measuring machine, execute measurement and analyze the measurement results; interpret, application and document requirements ISO 9001 for the organization; prepare and implement a TQM project for the organization.

**theoretical teaching**


**practical teaching**

Practical teaching embraces seven units: six auditory and one laboratory exercises, as well as seminar work in the area of quality standards. The content of auditory exercises is as follows:

The topic of the laboratory exercise is: The example of preparation for inspection on the CMM, simulation and generation of the measurement protocol. Development of six individually computational tasks from engineering analysis and synthesis using the quality engineering techniques. Quality management in practice - discussion and workshop (visit to the selected factory and familiarization with the functioning of ISO 9000 in practice).

**prerequisite**

Defined by curriculum of study programme.

**learning resources**

1. Handouts for each lecture. 2. The instruction for making individually tasks and seminar work. 3. The monograph in the field of quality and production metrology (in preparation). 4. The web site of the course with addresses of leading organizations and important institutions in this area (under preparation). 5. Facility and technical equipment: Laboratory for production metrology and TQM.

**number of hours**

- total number of hours: 75
- active teaching (theoretical)
  - lectures: 30
- active teaching (practical)
  - auditory exercises: 14
  - laboratory exercises: 3
  - calculation tasks: 5
  - seminar works: 8
  - project design: 0
  - consultations: 0
  - discussion and workshop: 0
  - research: 0
- knowledge checks
  - check and assessment of calculation tasks: 1
  - check and assessment of lab reports: 0
  - check and assessment of seminar works: 1
  - check and assessment of projects: 0
  - colloquium, with assessment: 4
  - test, with assessment: 4
  - final exam: 5

**assessment of knowledge (maximum number of points - 100)**

- feedback during course study: 10
- test/colloquium: 30
- laboratory exercises: 0
calculation tasks: 25
seminar works: 5
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references

Stojadinovic, S., (2018), Handouts for each lecture.
Stojadinovic, S., Majstorovic, V., The monograph in the field of quality and production metrology (in preparation)
Stanic, J., Products quality management - methods I, Faculty of Mechanical Engineering, Belgrade
Majstorovic, V., Products quality management I, Faculty of Mechanical Engineering, Belgrade
Stanic, J., Products quality management - methods II, Faculty of Mechanical Engineering, Belgrade
Railway vehicles maintenance

ID: MSc-0234

responsible/holder professor: Lučanin J. Vojkan

teaching professor/s: Lučanin J. Vojkan, Tanasković D. Jovan

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: oral

parent department: railway mechanical engineering

semester.position: 3.2

goals

Upon completion of the course the student should be able to:
1. Explain the basic concepts related to the reliability of rail vehicles.
2. Explain the basic concepts related to the maintenance of rail vehicles.
3. Explain the tasks and practices of the workshop for the maintenance of railway vehicles.
4. Perform appropriate calculations related to maintenance of rail vehicles.
5. Apply appropriate tools for computer calculations of electric and diesel electric locomotives.

learning outcomes

After successfully finishing of course students would be able to:
- define basic terms which are important for understanding of reliability and maintenance of railway vehicles;
- choose an appropriate approach to the maintenance of railway vehicles;
- solve practical problems of maintenance of railway vehicles directed to organisation, implementation of projected activities as well as implementation of knowledge in field of reliability, information and expert systems;
- make detailed scheme of the maintenance workshop of railway vehicles by using modern PC tools;
- discuss about possibilities of improving of the maintenance process using modern methods for monitoring of system failure.

theoretical teaching


practical teaching

Understanding the examples from the theory of reliability of the system. Application of the railway vehicles. Examples of the material. Methods of determining the distribution of the data set. Setting reliability requirements and measures for their achievement for rail vehicles.
Examples of the completed material. Application of computers in determining the reliability and information and expert systems in the maintenance of railway vehicles. Creating a computer program - information and expert system in the maintenance of railway vehicles. Visit the workshop for the maintenance of diesel and electric vehicles. Understanding the system of maintenance of rail vehicles.

**Prerequisite**

Nothing

**Learning resources**

It is necessary the use of textbooks, manuals for the project, a handout, computers and the Internet.

**Number of hours**

Total number of hours: 75

**Active teaching (theoretical)**

Lectures: 30

**Active teaching (practical)**

Auditory exercises: 15
Laboratory exercises: 0
Calculation tasks: 0
Seminar works: 0
Project design: 5
Consultations: 5
Discussion and workshop: 5
Research: 0

**Knowledge checks**

Check and assessment of calculation tasks: 0
Check and assessment of lab reports: 0
Check and assessment of seminar works: 0
Check and assessment of projects: 5
Colloquium, with assessment: 5
Test, with assessment: 0
Final exam: 5

**Assessment of knowledge (maximum number of points - 100)**

Feedback during course study: 10
Test/colloquium: 10
Laboratory exercises: 0
Calculation tasks: 0
Seminar works: 15
Project design: 30
Final exam: 35
Requirements to take the exam (number of points): 35
references

Dusan Stamenkovic, Maintenance of railway vehicles, Faculty of Mechanical Engineering - Nis, Serbia, 2011.
Reliability of structures

**ID:** MSc-0486  
**responsible/holder professor:** Ristivojević R. Mileta  
**teaching professor/s:** Ristivojević R. Mileta  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** general machine design  
**semester.position:** 3.2

**goals**

Acquisition of basic knowledge about the reliability of mechanical components and structures. Mastering the methods of determining the reliability of simple and complex systems. Developing skills of teamwork and networking knowledge and skills in various fields. Training for further study. Consideration of the importance failure from technical and economic point of view, mastering the skills to assess the failure assessment, based on the cause-events established classifications.

**learning outcomes**

After attended course, students gain knowledge about:
1. Explain the basic indicators of reliability,
2. Apply approximate procedures for determining the basic indicators of reliability of machine parts and structures,
3. Apply analytical procedures for the determination of the basic indicators of reliability of machine parts and structures,
4. Determine a parameters of the basic distribution on the basis of probability,
5. To analyze the influence of the distribution of operating and critical stress on the safety and reliability of machine parts and structures,
6. Determine the reliability of complex systems with series, parallel and combined connection of elements,
7. Construct machine parts and assemblies on the basis of reliability.

**theoretical teaching**

The importance of reliability in the design and construction process of mechanical structures. The definition of reliability. Key indicators of reliability. Estimated and theoretical reliability, confidence level. Reliability of elementary and partial function executor for various failure intensity function: constant function, linear and exponential growing function. Distribution of work and critical stress. Comparative analysis of the construction based on the degree of reliability and safety factor when the values of average operating stress and critical stress change in proportion, and the standard deviation does not change even when the mean values of operational and the critical stress does not change, with a change of standard deviation. The methodology of sizing of elements and joints based on the mechanical design reliability required. Reliability of mechanical structures for different connections (structure) elements: serial, parallel and combined. Statistical analysis of complex tolerance (tolerance of measuring chains). Optimizing the reliability cost. Correlation between reliability and safety factor for different relations of standard deviation and average values of operating and critical stress.
practical teaching


prerequisite

No

learning resources

Laboratory of Machine design, University of Belgrade, Faculty of Mechanical Engineering. Handouts, Presentations, Wireless Internet connection and access to the course Web presentation provided with useful links.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 14
laboratory exercises: 0
calculation tasks: 6
seminar works: 3
project design: 0
consultations: 6
discussion and workshop: 1
research: 0

knowledge checks

check and assessment of calculation tasks: 2
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 4
test, with assessment: 4
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 15
project design: 0
final exam: 50
requirements to take the exam (number of points): 26

references

Nikola Vujanovic,: The theory of reliability of technical systems, Vojnoizdavacki i novinski centar, Belgrade,1990
Gradimir Ivanović: Reliability of technical systems, Belgrade, 2011
Handouts
Seakeeping

ID: MSc-0697
responsible/holder professor: Bačkalov A. Igor
teaching professor/s: Bačkalov A. Igor
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: naval systems
semester.position: 3.2

goals

To cover the basic knowledge of Naval Architecture connected to ship motion in waves (seakeeping).

learning outcomes

Knowledge in solving and analysis of practical engineering tasks connected to ship motion (roll, heave, pitch) in regular and irregular waves.

theoretical teaching


practical teaching

Practical problems of seakeeping, illustrating the subjects lectured in theoretical syllabus. In addition, students have to accomplish individually the project on ship rolling, heaving and pitching in irregular waves, for the ship already analyzed in projects of Buoyancy and Stability of Ship.

prerequisite


learning resources

[1] Milan Hofman: Extracts from lectures (handouts) /In Serbian/
[3] I. Bačkalov: Instructions for seakeeping project. /In Serbian/

number of hours

total number of hours: 75
active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 10
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 40
final exam: 50
requirements to take the exam (number of points): 34

references

Lewis, Edward V. (editor), Principles of Naval Architecture, Part 3, SNAME 1987
A.R.J.M.Lloyd: Seakeeping - Ship Behaviour in Rough Weather
Vehicle Testing

**ID:** MSc-1143  
**responsible/holder professor:** Popović M. Vladimir  
**teaching professor/s:** Popović M. Vladimir  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** motor vehicles  
**semester.position:** 3.2

**goals**

The main objective of this course is to enable students to obtain objective information on the quality and performance of vehicles and their assemblies and parts at different stages of development, production and exploitation of vehicles using a series of procedures.

**learning outcomes**

Upon successful completion of this course, students should be able to: 1. Explain how to measure physical quantities electrically while testing motor vehicles; 2. Select transducers and sensors, amplifiers, supplementary and auxiliary devices and devices for displaying vehicle test results; 3. Conduct different vehicle tests; 4. Analyze test results.

**theoretical teaching**

Theoretical classes are focused on the following areas: basic concepts of testing, measuring instruments and installations and processing of test results (basic definitions, measuring quantities, types of tests, testing methodology, test results processing and test report writing); Measurement of physical quantities by electrical means (basic characteristics of transducers and sensors used for testing in the field of motor vehicles, measuring instruments, supplementary and auxiliary devices and devices for displaying test results); vehicle performance testing; vehicles workload testing, vehicle reliability testing.

**practical teaching**

Practical classes consist of the following laboratory exercises: testing of protective structures of agricultural tractors; testing of rear under-run protective device; testing of ambulance vehicle; testing by simulation in CarSim software; testing of vehicles for transport of perishable foodstuffs; testing of completed vehicles; testing of vehicles for transport of dangerous goods; testing of pedestrian warning sound system for installation on electric vehicles.

**prerequisite**

No special requirements.

**learning resources**

Handouts in digital form.

**number of hours**
total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 25
calculation tasks: 0
seminar works: 0
project design: 5
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 30
requirements to take the exam (number of points): 35

**references**

Handouts in digital form
-
Aircraft Design

ID: MSc-1132
responsible/holder professor: Grbović M. Aleksandar
teaching professor/s: Grbović M. Aleksandar, Svorcan M. Jelena
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: aerospace engineering
semester.position: 3.3

goals

This course aims to provide a comprehensive overview of conceptual design of an aircraft. A holistic teaching approach is taken to explore how the individual elements of an aircraft can be designed and integrated using up-to-date methods and techniques. Course includes analyses of existing airplanes and assessments of their strong and weak points with the aim of selecting optimum concept. Students are thought how to define basic geometric parameters of an aircraft, to select appropriate configuration and propulsion system, define loads and specific thrust/power. Performances and stability of the airplane are also covered.

learning outcomes

After attending all lectures and completion of projects students will be able to analyse, specify and develop aircraft concept according to required performances and purpose. They will have ability to define and select optimal aerodynamic scheme and determine essential design parameters. Also, they will know how to design aircraft parts and components efficiently and to prepare documentation for manufacturing using design software CATIA v5.

theoretical teaching


practical teaching

Practical work with lecturer serves to illustrate concepts through examples and to help students to complete their projects. After projects' completions students present their work to professors and other students of the department. Final grades depend on quality of the finished projects, student's activity during the school year, and the quality of presentations. During practical work students use software CATIA v5 and learn basics of part design, assembly design, sheet metal design and generative shape design.

prerequisite

As defined by curricula of study program.

learning resources
1. CAD laboratory (SimLab).
2. Software CATIA v5.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 5
consultations: 10
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 10
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 15
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 55
final exam: 30
requirements to take the exam (number of points): 30

**references**

A. Grbovic, M. Milos: Software Tools in Design, Faculty of Mechanical Engineering, Belgrade, 2017
Handouts
PowerPoint presentations
Air Pollution Control

ID: MSc-0124

**responsible/holder professor:** Radić B. Dejan

**teaching professor/s:** Obradović O. Marko, Radić B. Dejan

**level of studies:** M.Sc. (graduate) academic studies

**ECTS credits:** 2

**final exam:** written+oral

**parent department:** process and environmental protection engineering

**semester.position:** 3.3

**goals**

The goal of course is a review of basic design devices used in facilities whose purpose is the air pollution control. This is achieved through a review of the basic construction of apparatus for the purification of gases and review of methodology for calculations commonly used types of these devices. In this way the student masters the skills of designing these facilities and individual devices.

**learning outcomes**

Upon completion of the course is expected that the candidate has mastered the skills related to analysis and evaluation of application of air pollution control devices for a particular purpose. The knowledge that the student acquire the specific technical solutions, selection of treatment methods and equipment enabling the understanding of basic principles essential for the design of air pollution control installations and calculation of particular devices.

**theoretical teaching**

Apparatus for particulate emission reduction – Inertial and gravitational devices, centrifugal separators, electrostatic precipitators, fabric filters.

Apparatus for wet particulate and gas emission reduction – Spray towers, scrubbers (spray, cyclone, baffle, impigment etc), venturi scrubber.

Dry, wet and semidry gas emission control – wet scrubbers, absorbers, adsorbers, packed bed absorbers, condensers.

SOx, NOx and VOC control.

**practical teaching**

Design of settling chambers.

Design of centrifugal separators.

Design of fabric filters.

Design of wet scrubbers.

Design of Venturi scrubbers.

Material balances of air pollution control devices.

Design od apsorbers for gas cleaning.

NOx removal devices.

VOC removal devices.

Laboratory – measurement of particulate and gas emission.

**prerequisite**

Defined by curriculum of study program/module.
learning resources

2. Vuković, D, Bogner, M.: Cleaning technique, SMEITS, Belgrade, 1996, KDA
3. Experimental installation for air emission measurements, Laboratory for process engineering (room 6) EOP-LPI
4. Devices and apparatus for for air emission measurements, Laboratory for process engineering (room 6) EOP-LPI

number of hours

total number of hours: 30

active teaching (theoretical)

lectures: 12

active teaching (practical)

auditory exercises: 11
laboratory exercises: 1
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 1
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 15
test/colloquium: 0
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 70
requirements to take the exam (number of points): 20

references
Eco Design

ID: MSc-0127
responsible/holder professor: Zrnić Đ. Nenad
teaching professor/s: Zrnić Đ. Nenad
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: material handling, construction and logistics
semester.position: 3.3

goals

The main objective of this course is to achieve competence and academic skills in the field of eco design and sustainable product development. The goal is mastery of the methodologies to define strategies to improve products and reduce the harmful effects of products on the environment, and understanding of the impact of products on the environment throughout its life cycle and innovative approach to obtaining environmentally improved products.

learning outcomes

By completing this course student acquires ability to:
• analyse life cycle of a product using tools for life cycle assessment
• implement ecodesign strategies into design process and product development
• suggest measures for improvement of environmental performances of the product
• implement legislative in the field of ecology into design process
• design and develop sustainable product

theoretical teaching

Introduction into Eco-design, basic concepts and terminology, the impact of products on the environment. Eco-Design strategy, product modeling, recommendations for the selection of materials with low impact on the environment, the impact of production technologies, transport and packaging, as well the phase of product use and product end-of-life on the ecological impacts. The assessment of product life cycle, methodology of environmental impact, practical examples. Environmental communication and the EU measures for environmental protection, directive, eco-labels and declarations. Application of Eco-Design for the improvement of existing products. Design for disposal and recycling of waste products, design for waste minimization, design for dismantling of old equipment.

practical teaching

Terminology of Eco Design. Examples of impacts of products on the environment. Examples of eco-design strategies. Examples of analysis of product life cycle in terms of Eco-Design. Examples of improvements of existing products. Examples of disposal and recycling of used goods. Eco Design computer tools, training and work in a computer tool EcoDesign Pilot + Assistant + EEG, obtaining an improved product through several stages which include the identification of products, Eco Design strategies and concrete measures for improvement.

prerequisite

The conditions are defined in curriculum of the study program.
learning resources

1. Nenad Zrnic: Ecodesign, Handouts - Written lectures, 2011, DVL.
2. Computers with Internet connection, Lab 455, ICT / CAH
3. EcoDesign Pilot software + + Assistant EEG, TU Wien, ICT / CSP

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 4
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Ostad - ECODSIGN Sustainable Product Development, Vienna University of Technology, 2006, KCU.
Eco Design

ID: MSc-0127  
**responsible/holder professor:** Zrnić Đ. Nenad  
**teaching professor/s:** Zrnić Đ. Nenad  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** material handling, construction and logistics  
**semester.position:** 3.3

**goals**

The main objective of this course is to achieve competence and academic skills in the field of eco design and sustainable product development. The goal is mastery of the methodologies to define strategies to improve products and reduce the harmful effects of products on the environment, and understanding of the impact of products on the environment throughout its life cycle and innovative approach to obtaining environmentally improved products.

**learning outcomes**

By completing this course student acquires ability to:

- analyse life cycle of a product using tools for life cycle assessment  
- implement ecodesign strategies into design process and product development  
- suggest measures for improvement of environmental performances of the product  
- implement legislative in the field of ecology into design process  
- design and develop sustainable product

**theoretical teaching**

Introduction into Eco-design, basic concepts and terminology, the impact of products on the environment. Eco-Design strategy, product modeling, recommendations for the selection of materials with low impact on the environment, the impact of production technologies, transport and packaging, as well the phase of product use and product end-of-life on the ecological impacts. The assessment of product life cycle, methodology of environmental impact, practical examples. Environmental communication and the EU measures for environmental protection, directive, eco-labels and declarations. Application of Eco-Design for the improvement of existing products. Design for disposal and recycling of waste products, design for waste minimization, design for dismantling of old equipment.

**practical teaching**

Terminology of Eco Design. Examples of impacts of products on the environment. Examples of eco-design strategies. Examples of analysis of product life cycle in terms of Eco-Design. Examples of improvements of existing products. Examples of disposal and recycling of used goods. Eco Design computer tools, training and work in a computer tool EcoDesign Pilot + Assistant + EEG, obtaining an improved product through several stages which include the identification of products, Eco Design strategies and concrete measures for improvement.

**prerequisite**

The conditions are defined in curriculum of the study program.
learning resources

1. Nenad Zrnic: Ecodesign, Handouts - Written lectures, 2011, DVL.
2. Computers with Internet connection, Lab 455, ICT / CAH
3. EcoDesign Pilot software + + Assistant EEG, TU Wien, ICT / CSP

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 4
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Ostad - ECODESIGN Sustainable Product Development, Vienna University of Technology, 2006, KCJ.
Ecology of Mobile Power Sources

ID: MSc-1024
responsible/holder professor: Knežević M. Dragan
teaching professor/s: Knežević M. Dragan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: written+oral
parent department: internal combustion engines
semester.position: 3.3

goals


learning outcomes

Understanding the influence of human activities on environment, especially of harmful ones. Knowledge of pollutants formation chemistry, the greenhouse gases effects on global climate change, and noise of IC engines. Ability to apply solutions for pollutants and noise reduction.

theoretical teaching


practical teaching

b) Laboratory sessions: 1. Measurements of engine exhaust emissions with and without EGR.

prerequisite

**learning resources**

Handouts (PDF files); Instructions to carry out lab session and prepare and write report; numerical assignments examples; test bed with IC engine, measurement equipment and software for data acquisition, exhaust gases analizers.

**number of hours**

total number of hours: 45

**active teaching (theoretical)**

lectures: 18

**active teaching (practical)**

auditory exercises: 11
laboratory exercises: 3
calculation tasks: 2
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 1
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 3
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 30
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 50
requirements to take the exam (number of points): 30

**references**
Fracture mechanics and structural integrity

ID: MSc-0896

responsible/holder professor: Sedmak S. Aleksandar

teaching professor/s: Sedmak S. Aleksandar

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: oral

parent department: engineering materials and welding, tribology, fuels and combustion

semester.position: 3.3

goals

Objectives of this course are that students, after completing theoretical basic training in fracture mechanics, and with their maximum involvement in practical training (through laboratory exercises, development of computational tasks, writing seminar papers, etc.), become competent in the field of structural integrity and gain appropriate academic skills, and also develop specific creative and practical skills that are needed in professional practice.

learning outcomes

By attending this course, provided by the curriculum of the subject, the student will be able to solve particular problems of structural integrity, and to examine the possible consequences that may occur in case of bad solutions. The student will also able to link their knowledge in this field with other areas and apply them in practice.

theoretical teaching


practical teaching

Practical classes: Determination of fracture mechanics parameters in elastic and elastic-plastic field. Experimental, numerical and analytical methods. Standard procedures for measuring parameters of fracture mechanics, as well as material properties. Chart analysis of fracture and its application to welded joints and construction. Assessment of structural integrity of the given construction example by using all acquired knowledge. Consultation.

prerequisite

required: Materials strength, Mechanics, Fundamentals of structure integrity, Basic of Welding Process and Mechanical materials 1 and 2

learning resources

[1] Written lessons from lectures (handouts)

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 9
laboratory exercises: 4
calculation tasks: 7
seminar works: 15
project design: 0
consultations: 2
discussion and workshop: 3
research: 0

knowledge checks

check and assessment of calculation tasks: 1
check and assessment of lab reports: 1
check and assessment of seminar works: 2
check and assessment of projects: 0
colloquium, with assessment: 2
test, with assessment: 4
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 35
laboratory exercises: 10
calculation tasks: 5
seminar works: 15
project design: 0
final exam: 30
requirements to take the exam (number of points): 40

references

Fundamentals of Rail Vehicle Dynamics

**ID:** MSc-1190  
**responsible/holder professor:** Milković D. Dragan  
**teaching professor/s:** Milković D. Dragan, Simić Ž. Goran  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** railway mechanical engineering  
**semester.position:** 3.3

**goals**

1. Acquiring knowledge about the dynamic behavior of rail vehicles.  
2. Exploring methods for studying the dynamic behavior of rail vehicles.  
3. Training for the application of knowledge in the design, development, repair and maintenance of railway vehicles.

**learning outcomes**

After completion of the course the student should be able to:  
1. Explain the characteristic phenomena of dynamic behaviour of rail vehicles.  
2. Apply computational methods for determining the main parameters of the dynamic behaviour of the rail vehicles.  
3. Participate in the preparation of the test procedures for tests of the dynamic behaviour and proper assessment of the test results.  
4. Apply appropriate regulations for design or refurbishment of rolling stock in order to achieve the prescribed dynamic behaviour.

**theoretical teaching**


**practical teaching**

Examples of excitation: denivelation of the rails, out of roundness and eccentricity of the wheel, track deformations, harmonic deformations. Excitation simulation. Linear and nonlinear characteristics of elastic and damping elements. Linearization of the characteristics. Examples of one degree of freedom models. Typical dry friction elements used on rail vehicles. The model with dry friction. Example of two axle bogie model in the vertical plane. Effect of selection of generalized coordinates to equation coupling. Example of the freight
wagon model with bogies. Example of model of passenger coach two-stage suspension in the vertical plane. Solving problems with more degrees of freedom using computer software. Review of tests of passenger coach dynamic behaviour.

**prerequisite**

Previously passed courses in Mechanics of rigid bodies and at least 18 EPSB, with at least one course of Dynamics.

**learning resources**


**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 0
calculation tasks: 11
seminar works: 0
project design: 0
consultations: 4
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 6
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 40
laboratory exercises: 0
calculation tasks: 30
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30
references
Hydropower measurements

ID: MSc-0927
responsible/holder professor: Ilić B. Dejan
teaching professor/s: Božić O. Ivan, Ilić B. Dejan, Čantrak S. Đorđe
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: hydropower engineering
semester.position: 3.3

goals

Measurements have a very significant role in engineering practice and research activities. The measurements in hydro-energy systems include measuring fluid flow quantities and energy characteristics of hydraulic machinery, in order to determine the energy performance of turbines, pumps, fans and other turbomachines. In framework of this subject, the characteristics of valves and methods for determining the cavitation characteristics of hydraulic machines and equipment are studied in detail.

learning outcomes

On successful completion of this course, students should be able to:
1. Organize and carry out testing of hydraulic machines (turbines, pumps, fans and turbocompressors) in the laboratory, following applicable international standards,
2. Process, present and analyze test results and calculate measurement uncertainty of the measured values,
3. Perform a comparative analysis of number of ways for measuring the energy parameters of hydraulic machines,
4. Recalculated efficiency from a model to a prototype of turbine,
5. Explain the calibration of pressure, flow and torque measuring devices, process the measurement results of calibration and calculate measuring uncertainty following applicable international standards and recommendations.

theoretical teaching

- The importance of testing in hydro-energy systems. Model testing of hydraulic machineries;
- Standards and recommendations for model tests. Overview of measuring parameters;
- Turbine model test in the laboratory;
- Energy and cavitation characteristics determination of turbine models - the universal characteristics;
- Turbine test in hydro-power plants;
- Pump model tests in the laboratory;
- Energy and cavitation characteristics determination in pump models - the universal characteristics;
- Pumps test in pumping stations;
- Fan test in laboratory and ventilation systems;
- Compressor test in laboratory and compressor systems;
- Hydro-mechanical equipment test in the laboratory;
- Energy and cavitation characteristics determination of hydro-mechanical equipment (valves).
practical teaching

Auditory exercises:
- Measurements of physical quantities in hydro-energy system;
- Determination of pump energy and cavitation characteristics;
- Determination of turbine energy and cavitation characteristics;
- Determination of pump energy and cavitation characteristics at pump station;
- Determination of the energy performance of turbines in hydro-power plant.

Laboratory Exercise:
- Calibration of measuring equipment;
- Determination of universal characteristics of the pump and turbine model;
- Fan test in laboratory and ventilation systems.

prerequisite

Requirements for examination: Pumps, Hydraulic turbines, Fans and turbocompressors.
Preferred: Mechanical engineering measurements and sensors.

learning resources

[1] Hand-outs,
[2] Installation for testing the energy and cavitation features of turbine models, small hydro-power plants and hydro-mechanical equipment,
[3] Pelton turbine test rig
[4] Installation for flow visualization, determining pump hydraulic characteristics, variety of pump control possibilities, determining duct hydraulic characteristics
[5] Installation for flow meter calibration by volume method, testing of pumps and hydromechanical equipment
[6] Installation for flow meter calibration by volume method (56 l/s)
[7] Test rig for defining energy characteristics of the axial fans and swirl flow in diffusers (swirl chamber)
[8] Test rig with booster fan for fan and fluid flow phenomena investigations
[9] Installation for calibrating pressure gauges
[10] Calibration tunnel for velocity and pressure probes

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 10
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 0
laboratory exercises: 50
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 45
requirements to take the exam (number of points): 30

**references**

Miroslav Benišek "Hydraulic Turbines," Mechanical Engineering in Belgrade, 1998,
Industrial Management

ID: MSc-1043
responsible/holder professor: Dondur J. Nikola
teaching professor/s: Dondur J. Nikola
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: industrial engineering
semester.position: 3.3

goals
The aim of this subject is that students get know basic principles, methods and techniques of management in general, and especially in industrial enterprises. The aim is that students adopt knowledge and skills which will be solid basis for further requiring competences for autonomous and responsible participation in processes of business decisions in contemporary conditions.

learning outcomes
To get know of content Industrial Management the students get know modern knowledge from theory and practice of management in general, and especially in industrial enterprises, when accent is on achievement of competence to strengthen innovation as a key factor of competitiveness in turbulent business environment, local and international.

theoretical teaching

practical teaching
The practical work is consisted from discussion and workshops with special topics as well as characteristic industrial cases from local and word practice. Special attention will be paid to the problem of innovations, especially to technological innovations as a factor of competitiveness. Also, the questions of transition of management into leadership will be wider discussed, as well as other questions from contemporary business management. Beside that, practical work is used for preparation of seminar paper.

prerequisite
At least 50 points, when points from the practical exams are especially important.

learning resources
Beside cited literature and handouts, chosen internet links, as well as special prepared business cases, from local and the international practice, will be used.

Slobodan Pokrajac, Dragica Tomić, Management, (in Serbian), Alfa-graf, Novi Sad, 2011

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 0
consultations: 10
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 5
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 20
test/colloquium: 40
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 0
final exam: 30
requirements to take the exam (number of points): 50

**references**
C.M. Chang, Engineering Management: Challenges in the New Millenium, Pearson Prentice Hall, New Jersey, 2005
Intelligent manufacturing systems

ID: MSc-0131
responsible/holder professor: Miljković Đ. Zoran
Teaching professors/s: Miljković Đ. Zoran, Petrović M. Milica
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: project design
parent department: production engineering
semester.position: 3.3

goals

The aim of the course is to develop students' ability for conceptual design and implementation of intelligent manufacturing systems and processes by using the design theory, machine learning and evolutiveness, based on paradigms of artificial intelligence (AI). After he/she becomes familiar with the structure of intelligent manufacturing system based on multi-agent methodology (agents: robot, machine tool, machine learning, process planning, optimization, software, etc.) using laboratory equipment like reconfigurable mobile robots with sensors and laboratory model of designed manufacturing system as well as simulation by applying specialized software tools, the student will acquire knowledge necessary for the development of advanced production technologies.

learning outcomes

Students' learning outcomes of this course are:
• Implementation of developed software tools (e.g. TRIZ, Flexy) for modelling and analysis of intelligent manufacturing systems and processes.
• Selection of methods based on the application of artificial neural networks (by using software packages MATLAB, BPnet, ART Simulator) and other computational intelligence techniques in designing and building intelligence of artefacts (autonomous mobile robots can thus be observed interacting with their manufacturing environment) as well as scheduling of manufacturing entities.
• Advanced utilization of the software for discrete event simulation (AnyLogic, Flexy) with analysis and presentation of the experimental results obtained.
• Understanding the interaction of soft and hard real-time subsystems of autonomous mobile robot through reconfiguration and advanced programming in MATLAB.
• Capability for team work.

theoretical teaching

Introduction to knowledge and machine learning-based intelligent systems. Machine learning models; deduction, induction and analogy. Machine learning as a basis of intelligent systems and processes. Paradigms of AI; decision tree induction, artificial neural networks, genetic algorithms, case-based reasoning-CBR (learning from experience), etc. Evolutiveness and intelligent systems based on Multi-agent Systems Engineering (MaSE) methodology. Agents work autonomously; basic concepts and importance. Autonomous mobile robots; target cognitive capabilities of mobile robots including perception processing, collision avoidance, anticipation, path planning, complex motor coordination, reasoning about other agents, etc. Mobile robot localization and navigation (pose estimation) as well as characteristic objects detection in robotic exploration within the manufacturing environment. The design theory

**practical teaching**

Modelling and analysis of intelligent manufacturing systems and processes (laboratory work). Exemplified application of developed intelligent systems (laboratory work). Software for simulation of artificial neural networks (laboratory work). Software architectures for machine learning of intelligent systems. Intelligent behaviour of manufacturing system agents based on empirical control algorithm. Subsumption architecture for intelligent control based on achieving increasing pre-specified levels of competence in an intelligent robotic system (intelligent behaviour design of an autonomous mobile robot interacting with detected objects - programming in MATLAB). Scheduling plans optimization using genetic algorithms (programming in MATLAB). Software tools for conceptual design of FMS lay-out configurations (laboratory work). Project design (Material handling; Intelligent control of autonomous mobile robot; Scheduling of indoor transportation equipment).

**prerequisite**

Defined by Curriculum.

**learning resources**

[1] Z. Miljković, D. Aleksendrić, ARTIFICIAL NEURAL NETWORKS – solved examples with theoretical background (2nd ed.), Textbook, University of Belgrade, Faculty of Mechanical Engineering, 2018, 18.1 /In Serbian/
[4] Z. Miljković, M.M.Petrović, Handouts, University of Belgrade, Faculty of Mechanical Engineering, 2018, 18.1 /In Serbian/
[6] Z. Miljković, M.M.Petrović, Website for IMS (http://cent.mas.bg.ac.rs/), University of Belgrade, Faculty of Mechanical Engineering, 2018, 18.13
[7] B. Babić, FLEXY - Intelligent system for FMS design, Series IMS, Vol. 5, University of Belgrade, Faculty of Mechanical Engineering, 1994, 18.1 /In Serbian/
[8] Laboratory mobile robot prototype (Khepera II mobile robot with gripper and camera; LEGO Mindstorms NXT and LEGO Mindstorms EV3 Sets of reconfigurable mobile robots equipped with sensors and microcontrollers), Laboratory CeNT, University of Belgrade, Faculty of Mechanical Engineering, 18.12
[9] Laboratory model of designed manufacturing system, Laboratory CeNT, University of Belgrade, Faculty of Mechanical Engineering, 18.12
[10] Software packages (MATLAB, BPnet, ART Simulator, AnyLogic, TRIZ, Flexy), Laboratory CeNT, University of Belgrade, Faculty of Mechanical Engineering, 18.13

**number of hours**

636
total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 15
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 4
colloquium, with assessment: 2
test, with assessment: 4
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 15
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 35
final exam: 30
requirements to take the exam (number of points): 30

**references**

Marine Engines

**ID:** MSc-1025  
**responsible/holder professor:** Knežević M. Dragan  
**teaching professor/s:** Knežević M. Dragan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 4  
**final exam:** written+oral  
**parent department:** internal combustion engines  
**semester.position:** 3.3

**goals**

The target of this subject is to give a comprehensive insight into the specific matter of IC marine engines, two-stroke, as well as four- stroke ones, and especially of high power engines with complex engine mechanism. The subject is intended for the students of Shipbuilding department who will be given an introduction for further later research into construction specifications of this class of engines and engine systems during professional practical work experience.

**learning outcomes**

General specifications: Adopted basic theoretical and practical knowledge in the field of IC marine engines where fundamental and applied scientific disciplines are entangled. Students acquire basic ability for competent approach to the choice, organization of exploitation and maintenance of engines in the field of marine engine systems.

**theoretical teaching**


**practical teaching**

b) Laboratory training: Engine testing- measuring of the propelling characteristics of the engine.
prerequisite

No prerequisites required.

learning resources

Handouts, available in electronic version in PDF format on the site of IC Engine department. Instructions for the demonstration of laboratory experiment and electronic report writing laboratory installation-test bench with IC engine, measuring equipment and the software for measuring data acquisition.

number of hours

total number of hours: 45

active teaching (theoretical)

lectures: 12

active teaching (practical)

auditory exercises: 18
laboratory exercises: 4
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 4
final exam: 3

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 25
laboratory exercises: 25
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

references
Marine turbines and boilers

**ID:** MSc-1121  
**responsible/holder professor:** Stupar M. Goran  
**teaching professor/s:** Stupar M. Goran  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 2  
**final exam:** written  
**parent department:** thermal science engineering  
**semester.position:** 3.3

**goals**

Reaching the competence and academic skills and methods for it's acquiring. Developing creative capabilities and mastering the specific practical skills. Goals determine the specific results which should be achieved within the subject. Goals also represent basis for control of the achieved results.

**learning outcomes**

After successfully completing the course, the students will be able to:  
- Determine the steam, heat and fuel marine plants consumption.  
- Acquainted with the characteristics and types of marine boilers and utilizor boiler.  
- Acquainted with thermodynamic parameters for marine turbo plant and its main elements.  
- Acquainted with the marine gas turbines and its basic thermodynamic parameters.  
- Acquainted with the combined gas and steam turbine plants.  
- Acquainted with the basic scheme of marine nuclear plants.

**theoretical teaching**

Introduction; Efficiency and consumption of steam, heat and fuel for marine steam boiler;  
Fossil fuels marine steam boilers - fuel, combustion material balance, flue gases enthalpy, marine boiler heat balance; Marine waste heat boilers – in general; Thermodynamic cycles and heating block diagram; Basis and the main thermodynamic parameters of steam turbine plants; transformation of energy in steam turbines; Steam turbines basic elements;  

**practical teaching**

Auditory exercises consist from demonstration exercises - (Boiler division by steam and water mixture flow in the evaporator; Marine steam boiler construction; Marine steam block boilers; Water tube boiler; Fossil fuel marine boiler placing; Marine waste heat boilers construction; Basics of nuclear propulsion; Presentation of steam turbines design and their application; presentation of gas turbines design and their application); Working assignement - Calculation of main thermodynamic parameters and heating block diagram; Determining the losses, efficiency and fuel consumption of the given marine steam boiler.

**prerequisite**

Necessary condition: Bachelor’s degree.
learning resources


number of hours

total number of hours: 30

active teaching (theoretical)

lectures: 12

active teaching (practical)

auditory exercises: 8
laboratory exercises: 0
calculation tasks: 4
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 1
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 10
laboratory exercises: 0
calculation tasks: 30
seminar works: 0
project design: 0
final exam: 50
requirements to take the exam (number of points): 25

references
Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers, Faculty of Mechanical Engineering, Belgrade, 2010, (In Serbian)
Lj. Brkic, T. Zivanovic, D. Tucakovic: Steam Boilers Thermal Calculation, Faculty of Mechanical Engineering, Belgrade, 2010, (In Serbian)
Vasiljević, N.: Steam turbines, Faculty of Mechanical Engineering, Belgrade, 1987. (in serbian)
Nanomedical Engineering

ID: MSc-0728
responsible/holder professor: Matija R. Lidija
teaching professor/s: Matija R. Lidija
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: control engineering
semester.position: 3.3

goals

Student will get knowledge of nanotechnology applications in medicine together with good practical laboratory work in characterization of biomaterials with nanotechnological methods, techniques and instrumentation. Student will get knowledge of modern diagnostics and therapeutic nanotechnological methods in medicine and will learn how to prepare classical and biological samples and to characterize them with nanotechnological instrumentation.

learning outcomes

Upon successful completion of this course, students will be able to:

• Distinguish principles of operation and the specific conditions of application of the devices in the field of nanotechnology in medicine
• Recognize the advantages of new medical devices in the field of nanotechnology as opposed to solutions in classical medical devices
• Give suggestions of modification of technical solutions in nanotechnologies with a review to their effective application in medicine
• Write and present scientific work in accordance with the standards of professional quality and in quality equal to the works published in professional journals

theoretical teaching


**practical teaching**


**prerequisite**

Fractal Mechanics, Biomaterials in medicine and stomatology, Signal processing, Nanotechnology

**learning resources**

Written material for every lecture (Handouts), NanoLab: modern NanoProbe device with STM/AFM/MFM, Opto-magnetic spectroscopy device, Chemical Vapor Deposition for thin (nano) films, UV/VIS spectometer, NIR spectometer, microscopy

**number of hours**

Total number of hours: 75

**active teaching (theoretical)**

Lectures: 30

**active teaching (practical)**

Auditory exercises: 20
Laboratory exercises: 5
Calculation tasks: 0
Seminar works: 4
Project design: 0
Consultations: 1
Discussion and workshop: 0
Research: 0

**knowledge checks**
check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 7
test, with assessment: 0
final exam: 3

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 45
laboratory exercises: 0
calculation tasks: 0
seminar works: 20
project design: 0
final exam: 30
requirements to take the exam (number of points): 40

**references**

Malsch, H.N., Biomedical Nanotechnology, CRS Press, Boca Raton, 2005
Nonlinear Systems 2

ID: MSc-0609  
responsible/holder professor: Jovanović Ž. Radiša  
teaching professor/s: Jovanović Ž. Radiša  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written  
parent department: control engineering  
semester.position: 3.3

goals

• Building the foundations of nonlinear control design and analysis.  
• Introducing commonly used nonlinear control tools.  
• Analysis and control of nonlinear systems using Matlab and Labview programming software.

learning outcomes

Knowledge and understanding of:  
• The basis of analysis of certain classes of nonlinear systems.  
• The methods for testing the system stability by Lyapunov techniques and input-output analysis.  
• The techniques of control of nonlinear systems.  
• Simulation, analysis and control of nonlinear systems and design using programming software Matlab and LabView.

theoretical teaching


practical teaching

PA:  
Practical work includes computational exercises that follow the content of course:  
stability of Lurie direct and indirect systems; determination stability of nonlinear systems using linear and Aizerman conjecture; Popov's and circle criteria; exact (feedback) linearization: input-state linearization, input-output linearization; zero dynamics and input-to-state stability; sliding mode control: backstepping-gain scheduling; describing function analysis; modified Nyquist criteria.

PL:  
Application programming languages C and Matlab in the analysis, simulation and control of nonlinear systems.  
Practice and experiments: analysis, design and simulation of nonlinear systems; experimental application of nonlinear control algorithms using the PC and the software Matlab/Simulink.
and LabView on different control plants (DC servo motor, inverted pendulum, coupled tanks experiment, ball and beam system).

**prerequisite**

Defined by curriculum of the study programme.

**learning resources**

- Lj.Grujić, D. Lazić, Nonlinear systems, Lecture notes in electronic form
- Radiša Jovanović, Nonlinear systems 2, Lecture notes
- Radiša Jovanović, Matlab and Simulink in Automatic Control, Faculty of Mechanical Engineering, Belgrade,
- Modular educational real time control system with various control plants (DC servo motor, inverted pendulum, double inverted pendulum, heat flow experiment, coupled water tanks experiment), with acquisition hardware and software,
- Electrohydraulic control system,
- PC and PC Embedded controllers, Siemens Simatic PLC, National Instruments controllers,
- Installation for control system testing and acquisition of electrical variables,
- Automatic Control Laboratory, Intelligent Control Systems Laboratory, Control Systems Laboratory.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 20
laboratory exercises: 5
calculation tasks: 5
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 3
check and assessment of lab reports: 3
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**
feedback during course study: 5

test/colloquium: 50

laboratory exercises: 5

calculation tasks: 10

seminar works: 0

project design: 0

final exam: 30

requirements to take the exam (number of points): 30

references

**Numerical Methods in Continuum Mechanics**

**ID:** MSc-1149  
**responsible/holder professor:** Bengin Č. Aleksandar  
**teaching professor/s:** Bengin Č. Aleksandar, Mitrović B. Časlav  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** information technologies  
**semester.position:** 3.3

**goals**

Introducing students with engineering simulations based on continuum mechanics. Understanding a well-defined problem as a unity of physical laws and additional conditions that define uniqueness and existence of a solution. Learning about the influence of the type of problem on the choice and type of additional conditions, as well as the choice of approximation to solve typical problems in continuum mechanic. Training students to independently develop computer programs for simulation of prototypical equations.

**learning outcomes**

By successfully adopting the program of the course, a student: acquires theoretical knowledge sufficient to recognize the type of the problem as well as the type and number of additional conditions necessary to completely and uniquely define the problem that is being simulated; recognizes basic approximation schemes of the typical problems; masters the principles and foundations of programming related to simulations of continuum; observes the structure of the simulation software that consists of pre-processing, simulation and visualization.

**theoretical teaching**


**practical teaching**

Practical training accompanies materials presented during theoretical lectures. In the beginning, students are registered and they familiarize with working in Linux operating system. After that, illustrative examples are completely presented starting with the problem formulation, presentation of the appropriate equations and their approximation, stability and convergence studies, code and reading of the necessary input data, finishing with presenting solutions graphically. Students solve their homework independently and present it to their colleagues.

**prerequisite**

Without prerequisites.

**learning resources**
Linux cluster, GNU C/C++ compiler.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 20
calculation tasks: 0
seminar works: 5
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 10
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 15
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 55
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**

Lectures in electronic form.
Optical devices and optoelectronics

ID: MSc-0123
responsible/holder professor: Micković M. Dejan

teaching professor/s: Micković M. Dejan

level of studies: M.Sc. (graduate) academic studies
ECTS credits: 2

final exam: oral

parent department: weapon systems

semester.position: 3.3

goals

The aim of this course is to enable students, future mechanical engineers - designers of military systems, the acquisition of knowledge necessary to the cooperation with the designers of complex optical and optoelectronic systems. After completion of lectures and exercises, students should be able to set and calculate basic optical systems.

learning outcomes

The subject allows students, future mechanical engineers - designers of military systems to:
- Set up basic optical systems (lenses, working systems, oculars, Kepler and Galileo's scheme of telescope system);
- Calculate an optical system using sophisticated codes for optical system design.

theoretical teaching

Basic assumptions and definitions used in optics.
Ideal and paraxyal optics as the basic approximations used in the design of optical systems.
1. Theory of aberrations and the theory that defines the deviation of real established character from an ideal character.
2. Rating the quality of image formed by optical systems.
3. Losses of light energy during propagation through the optical system.

practical teaching

1. Description of the major optical components that make up the conventional optical systems.
2. Calculation of ideal and paraxyal rays propagation through the optical system.
3. Calculation of real rays propagation through the optical system.
4. Design of a telescopic system (Kepler and Galileo's telescope system scheme).
5. Working principle of the picture amplifier.
7. Working principle of the laser and review of basic components that make up the laser system. Explained in detail the laser rangefinder.
8. Working principle of thermal imaging and review of the basic components of different types of thermal imaging units.

prerequisite
There are no special conditions for attending the subject.

**learning resources**

1. Vasiljević D.: Optical Devices and Optoelectronics, Facultz of Mechanical Engineering, Belgrade, 2005
2. Software package OSLO – Optical Surface Layout and Optimization LT ver. 5.4 OSLO Optics Reference Manual, CCO

**number of hours**

total number of hours: 30

**active teaching (theoretical)**

lectures: 12

**active teaching (practical)**

auditory exercises: 6
laboratory exercises: 0
calculation tasks: 0
seminar works: 6
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 1
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

**references**
Plant and process design and energy systems

ID: MSc-0796  
responsible/holder professor: Marković D. Dragan  
teaching professor/s: Marković D. Dragan  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written+oral  
parent department: agricultural engineering  
semester.position: 3.3

goals

Mastering the knowledge necessary for the calculation and design of plant and process and energy systems and their use. This includes the development of creative abilities and mastery of specific practical skills for performing tasks in engineering practice.

learning outcomes

After successful completion of this course, studenty should be able to:
• Define the basic principles of design,
• Describe the facility design,
• Performed thermodynamic calculations with a choice of calculation of parameters of external and internal air,
• Projected process systems of animal and poultry facilities, plants and drying systems in the food industry,
• Organize storage space.

theoretical teaching

1.0. Introductory remarks. 2.0. Historical development of the facilities with protected space: Review of typical solutions; Basic ways of providing microclimate; Basic systems for the provision of micro-climate; Definition of working conditions of the protected space objects and calculations; Thermo-technical calculations and defining the mathematical model; Definition and development of a program for optimization of buildings with protected space. 3.0. Design of devices and installations for drying; Calculations for pneumatic - rotary and rotary dryers; Determination of structural parameters of pneumatic - rotary dryers; Constructive dimensions of multipass rotary dryer chamber; Methods of determining the drying regime. 4.0. Wind turbine theory, the coefficient of efficiency of wind energy: Aerodynamic characteristics of wind turbines; Control systems for rotation speed and power output of wind turbines, and auto orientation of wind turbine circuit when the direction of the wind change; Selection of solution and calculation of power of the wind turbine; Main components of the wind power plant. 5.0. Design of biogas plants: The principle of constructing the digester; Heating the substrate; Sizing of pipe heaters; Insulation of digester vessels. 6.0. Design of biomass power plants: Basic principles of energy valorization; Briquetting; Pelletizing; Cogeneration and trigeneration; Concept solutions for high temperature saw dust drying plant. 7.0. Heat pump: Ground connection

practical teaching

Practical Studies: Seminar paper is given out some of these theoretical entities in order to introduce students to existing solutions, their characteristics and monitoring developments in the field covered by the syllabus. Laboratory Exercise: Determining floating rate of various...
materials (depending on the type, shape, size, humidity, etc.). Calculations are made for the purpose of defining and dimensioning of characteristic solutions of some of the theoretical whole. A project is made with the technical documentation depending on the selected theoretical entities, which is a continuation of the development of computational tasks. Projects include the choice of concepts for plant and process design and energy systems, calculation and dimensioning of components and corresponding drawings.

**prerequisite**

defined curriculum of study program / module

**learning resources**


**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0 laboratory exercises: 0 calculation tasks: 10 seminar works: 5 project design: 15 consultations: 0 discussion and workshop: 0 research: 0

**knowledge checks**

check and assessment of calculation tasks: 0 check and assessment of lab reports: 0 check and assessment of seminar works: 4 check and assessment of projects: 4 colloquium, with assessment: 0 test, with assessment: 2 final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 20 test/colloquium: 10
laboratory exercises: 0  
calculation tasks: 10  
seminar works: 20  
project design: 10  
final exam: 30  
requirements to take the exam (number of points): 35

references

Фатеев М. Е., (1946), Wind turbines, State energy publisher, Leningrad.  
Knap V., Kulišić P., (1985), New sources of energy, School Book, Zagreb  
Plant and process design and energy systems

ID: MSc-0796
responsible/holder professor: Marković D. Dragan
teaching professor/s: Marković D. Dragan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: agricultural engineering
semester.position: 3.3

goals

Mastering the knowledge necessary for the calculation and design of plant and process and energy systems and their use. This includes the development of creative abilities and mastery of specific practical skills for performing tasks in engineering practice.

learning outcomes

After successful completion of this course, studenty should be able to:
• Define the basic principles of design,
• Describe the facility design,
• Performed thermodynamic calculations with a choice of calculation of parameters of external and internal air,
• Projected process systems of animal and poultry facilities, plants and drying systems in the food industry,
• Organize storage space.

theoretical teaching

1.0. Introductory remarks. 2.0. Historical development of the facilities with protected space: Review of typical solutions; Basic ways of providing microclimate; Basic systems for the provision of micro-climate; Definition of working conditions of the protected space objects and calculations; Thermo-technical calculations and defining the mathematical model; Definition and development of a program for optimization of buildings with protected space. 3.0. Design of devices and installations for drying; Calculations for pneumatic - rotary and rotary dryers; Determination of structural parameters of pneumatic - rotary dryers; Constructive dimensions of multipass rotary dryer chamber; Methods of determining the drying regime. 4.0. Wind turbine theory, the coefficient of efficiency of wind energy: Aerodynamic characteristics of wind turbines; Control systems for rotation speed and power output of wind turbines, and auto orientation of wind turbine circuit when the direction of the wind change; Selection of solution and calculation of power of the wind turbine; Main components of the wind power plant. 5.0. Design of biogas plants: The principle of constructing the digester; Heating the substrate; Sizing of pipe heaters; Insulation of digester vessels. 6.0. Design of biomass power plants: Basic principles of energy valorization; Briquetting; Pelletizing; Cogeneration and trigeneration; Concept solutions for high temperature saw dust drying plant. 7.0. Heat pump: Ground connection

practical teaching

Practical Studies: Seminar paper is given out some of these theoretical entities in order to introduce students to existing solutions, their characteristics and monitoring developments in the field covered by the syllabus. Laboratory Exercise: Determining floating rate of various
materials (depending on the type, shape, size, humidity, etc.). Calculations are made for the purpose of defining and dimensioning of characteristic solutions of some of the theoretical whole. A project is made with the technical documentation depending on the selected theoretical entities, which is a continuation of the development of computational tasks. Projects include the choice of concepts for plant and process design and energy systems, calculation and dimensioning of components and corresponding drawings.

**prerequisite**

defined curriculum of study program / module

**learning resources**

2. Topic M. Radivoj, Design and construction of agricultural facilities (theory and laboratory exercises performed), Faculty of Mechanical Engineering, 1996., PRA
3. Topic M. Radivoj, Martin Bogner, Drying technology, the Institute for publishing and teaching aids, Belgrade, 2002., KPN

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 10
seminar works: 5
project design: 15
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 4
check and assessment of projects: 4
colloquium, with assessment: 0
test, with assessment: 2
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 20
test/colloquium: 10
laboratory exercises: 0  
calculation tasks: 10  
seminar works: 20  
project design: 10  
final exam: 30  
requirements to take the exam (number of points): 35  

references  
Фатеев M. E., (1946), Wind turbines, State energy publisher, Leningrad.  
Knap V., Kulišić P., (1985), New sources of energy, School Book, Zagreb  
Steam generators

**ID:** MSc-0129  
**responsible/holder professor:** Stevanović D. Vladimir  
**teaching professor/s:** Milivojević S. Sanja, Stevanović D. Vladimir  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** thermal power engineering  
**semester.position:** 3.3

**goals**

The aims of the subject are acquiring academic knowledge about processes and equipment for steam generation in thermal power plants, building and mastering skills in scientific and engineering methods for the prediction, analyses and research of thermal-hydraulic processes in steam generators, as well as skills in methods for the design, safety analyses and diagnostics of the operational conditions of the steam generators.

**learning outcomes**

Mastering the course the students are able to simulate and analyze processes, design equipment and prescribe operational conditions in steam generators by applying the modern scientific and engineering methods for various conditions of exploitation. Also, the application of acquired knowledge and skills in every stage of design, manufacture and exploitation provide the safe, reliable and economically and energetically efficient operation of steam generators.

**theoretical teaching**

Design of steam generators; thermal-hydraulic parameters of vapour and liquid two-phase flow: static, flow and thermodynamic quality, vapour void fraction, two-phase mixture density, superficial velocity, two-phase flow mass flux, slip factor, drift velocity, etc.; heat transfer mechanisms in convective heating, boiling and superheating of working fluids or heat carriers; the critical heat flux; pressure change in two-phase flow; modelling of thermal-hydraulic processes in steam generators: the homogeneous model, the slip model, the two-fluid and multi-fluid models of two-phase mixture flows; numerical methods for solving the thermal-hydraulic models of two-phase flow; computer simulations of operational conditions of steam generators; pressure waves propagation and dynamic loads of pipelines in transient conditions; the choked flow; the condensation induced water hammer; two-phase flow instabilities; steam separation.

**practical teaching**

filled with vapour and liquid phases.

**prerequisite**

Passed exams in Thermodynamics, Fluid mechanics and Numerical methods.

**learning resources**

Subject handouts.
Personal computers.
Software for the solving of systems of differential equations.
Software for the simulation and analyses of pressure transients in pipeline networks and pressurizers.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 5
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 25
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 35
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 30
requirements to take the exam (number of points): 30

references

Terminal Ballistics

ID: MSc-0691
responsible/holder professor: Elek M. Predrag
teaching professor/s: Elek M. Predrag
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: written
parent department: weapon systems
semester.position: 3.3

goals

The main goal of the subject is that students understand the importance, the basic concepts and methods of terminal ballistics, as an integral part of the science of weapons systems. Students should understand the key ideas about the projectile/target interaction and their use in projectile design as well as ballistic protection.

learning outcomes

After successful completion of the course, students should be able to:
- define all types of projectiles/warheads action on targets,
- calculate the main parameters of all types of penetration processes,
- analyze the characteristics of blast effect,
- model the mechanisms of high-explosive projectiles fragmentation effect,
- apply the experimental methods for determination of projectile efficiency parameters,
- understand the functional composition and the fundamentals of fuze design.

theoretical teaching

1. Scope of terminal ballistics
2. Penetration mechanics
3. Fragmentation
4. Blast effect
5. Fuzes

practical teaching

1. Approaches to solving problems in terminal ballistics
Examples of target kill probability. Models of material behavior under dynamic loads.
2. Penetration/Perforation
Simple penetration models penetration for thin targets. Penetration at high velocities.
3. Penetration/Perforation
Models of shape charge jet and long rod penetration.
4. Workshop - Preparation of the paper with a topic that is determined by arrangement with the student.
5. Fragmentation
Experimental evaluation of the efficiency of projectile fragmentation.
6. Blast effect
Determination of blast effect parameters.
7. Fuzes
Models of the effect of certain types of fuzes. Calculation of reliability and safety of fuzes.

prerequisite
Exams passed (preferred): Projectile design, Physics of explosive processes

learning resources

number of hours

total number of hours: 45

active teaching (theoretical)
lectures: 18

active teaching (practical)
auditory exercises: 5
laboratory exercises: 0
calculation tasks: 9
seminar works: 2
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks
check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 3
check and assessment of projects: 0
colloquium, with assessment: 3
test, with assessment: 0
final exam: 3

assessment of knowledge (maximum number of points - 100)
feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references

Theory of finite element method

ID: MSc-1133
responsible/holder professor: Buljak V. Vladimir
teaching professor/s: Buljak V. Vladimir, Grbović M. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: strength of structures
semester.position: 3.3

goals

The objective of this course is to provide thorough methodological introduction to the Finite Element Method. Within the introductory part students will get familiar with the application of this method for solving boundary value problems in the elasticity. Emphasis will be given to formulation of weak form of problems both in statics and dynamics. The main goal of the course is to present to the students how displacement based finite elements can be used to solve linear problems. Detailed derivation of stiffness matrix will be shown with reference to finite elements of various types (both structural and continuum elements). Various techniques for the application of boundary conditions, and different methods for solving linear algebraic equations will be outlined. Post processing techniques and recovery of strain and stress fields based on nodal displacements for finite elements of different types will be presented in a detailed manner. In closing sessions of the course students will be shown some of the most popular commercial software used for static and dynamic analysis of structures.

learning outcomes

Upon completing the course students will be able to:
-Write computer codes for the assembling of stiffness matrix for truss-, beam-, frame- and shell-elements, as well as continuum 2-dimensional and 3-dimensional finite elements;
-Perform both static and dynamic analysis of simple structures within personally developed computer codes;
-Write computer codes for the stress and strain recovery based on linear, small-deformation theory, starting from resulting nodal displacements;
-Understand basics on which most commercial software are build and use them for performing static and dynamic analysis of more complex structures.

theoretical teaching


practical teaching

Writing computer codes in MATLAB software, for truss-, beam, frame-, shell-elements, as well as continuum 2D and 3D elements. Assembling of global stiffness matrix and mass matrix. Application of boundary conditions: concept of reduced stiffness matrix, and
alternative solution with Lagrange-multipliers technique. Developing codes for strain and stress recovery. Static and dynamic analysis of structures.

**prerequisite**
Passed exam Theory of elasticity

**learning resources**
Each student should have the access to the personal computer.

**number of hours**
total number of hours: 75

**active teaching (theoretical)**
lectures: 30

**active teaching (practical)**
auditory exercises: 15
laboratory exercises: 10
calculation tasks: 5
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**
check and assessment of calculation tasks: 5
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 3
test, with assessment: 5
final exam: 2

**assessment of knowledge (maximum number of points - 100)**
feedback during course study: 0
test/colloquium: 20
laboratory exercises: 5
calculation tasks: 5
seminar works: 0
project design: 0
final exam: 70
requirements to take the exam (number of points): 0

**references**
"The finite element method - a practical course" G.R. Liu S. S. Quek.
"An Introduction to the Finite Element Method" J.N. Reddy
"The Finite Element Method: Linear Static and Dynamic Finite Element Analysis", T. Hughes
"Finite Element Method: Volume 1" O. C. Zienkiewicz and R. L. Taylor
Vehicle Maintenance

**ID:** MSc-0875  
**responsible/holder professor:** Vasić M. Branko  
**teaching professor/s:** Vasić M. Branko, Popović M. Vladimir  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** motor vehicles  
**semester.position:** 3.3

**goals**

Student acquires relevant theoretical and practical knowledge about after sales activities of a vehicle manufacturer, and in particular concerning vehicle maintenance and the ways of establishing a system of authorized service organizations taking into consideration that without application of an appropriate maintenance system there will be no normal vehicle operation nor vehicle usage.  
An automotive engineer must know how to make a vehicle, but also how to use and maintain it in order to enable its mission to be fulfilled in all usage conditions.  
An automotive engineer must be educated and trained to design so called "Vehicle Maintenance System" i.e. to design programs and plan of preventive, corrective and combined maintenance as well as to design vehicle service technology and facilities in which it can be applied.

**learning outcomes**

Upon successful completion of this course, students should be able to:  
- Explain the processes of technical maintenance of different motor vehicle types and categories;  
- Do analysis of state changes of motor vehicles and identification of their causes (state changes due to the wrong using in vehicle exploitation, state changes due to the fatigue and wear, state changes due to the wrong maintenance of vehicle;  
- Organize and implement different concepts and methodologies of vehicle maintenance;  
- Determine necessary logistic and system support during vehicle maintenance (management of: spare parts, human resources, vehicles upon receipt in services (which depends of planned operations etc.));  
- Solve practical problems regarding to the processes of vehicle maintenance;  
- Recognize key performance indicators of maintenance;  
- Design service for vehicle maintenance according to the planned maintenance operations and types and categories of vehicle which will be maintenance in that service, through determination of the following parameters: production program, number of workers and work places, number and types of service work spaces;  
- Determine the technical equipment for designed vehicle service (diagnostic systems, tools etc.);

**theoretical teaching**

Theoretical tuition is composed of four blocks each of them containing four thematic units with an overall number of $4 \times 5 = 20$ lecturing hours, with $4 \times 2.5 = 10$ additional hours for working out on the teaching subjects and acquisition of new material.  
Four basic theoretical tuition blocks contains (a) Maintenance - Life cycle, and investment
effectiveness, Condition Time Sequence, Maintenance technological backgrounds, Variation of technological solutions, usage and maintenance in specific conditions, (b) Maintenance technologies (corrective, preventive, combined), Vehicle condition changes, Vehicle condition estimation methods, Technological procedures, (c) Project assignment, Number of vehicles to maintenance, Estimation of maintenance system capacity, Quality of Service, and (d) Kinds of maintenance technology processes, Maintenance Work place, Information systems, Logistics, Standardized and specialized service facilities.

**practical teaching**

In the practical tuition part student has 30 hours of individual work to work out a seminar work and a project. In the practical tuition part, following the aforementioned four main blocks, student works out more detailed thematic evaluation within the listening exercises followed by an individual seminar assignment about designing maintenance system for a given vehicle and an individual project assignment about maintenance system for a given service facility based on the knowledge acquired within the third and the fourth block. Student will also work out on a assignment considering maintenance logistics support as an integral part of the maintenance system, will deal with the selection and choice of garage equipment for a given work place, and will also deal with the dimensioning of maintenance capacities, in addition to some basic elements concerning an information system about operation and service of vehicles, and maintenance system specification.

**prerequisite**

A B.Sc. diploma in automotive engineering is preference, and already passed exams in “Vehicle design 1” and “Vehicle design” are a must.

**learning resources**

1. Class room
2. Subject teacher's book
3. Subject teacher's book
4. other literature type
5. IT Hardware
6. IT software

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 0
seminar works: 5
project design: 10
consultations: 3
discussion and workshop: 2
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 40
requirements to take the exam (number of points): 30

**references**

Ventilating and Air Conditioning Systems

**ID:** MSc-1122  
**responsible/holder professor:** Sretenović A. Aleksandra  
**teaching professor/s:** Živković D. Branislav, Sretenović A. Aleksandra  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** thermal science engineering  
**semester.position:** 3.3

**goals**

Getting knowledge and skills in air conditioning - various central air conditioning systems; mastering methods for calculating air ducts, choosing elements for intake and extract of air, and using those methods in air conditioning project design.

**learning outcomes**

Upon successful completion of the course, students should be able to:
- Select the appropriate elements for supply air inlet in the air-conditioned room in order to achieve optimal air distribution in space
- Apply of different methods for the calculation of pressure drop in air ducts
- Explain the basic features central air conditioning systems (all air and air to water systems)
- Apply measures to increase energy efficiency of the air conditioning systems
- Estimate of the advantages and disadvantages of different systems for ventilation and air conditioning
- Apply their knowledge to solving practical problems in air conditioning development, design and installation
- Be efficient in teamwork

**theoretical teaching**

Air distributing elements; duct calculation methods; air distribution; airflow range; air inlet and extract position; air conditioning systems - classification; central single-duct low pressure system with constant air volume, zone air conditioning systems; high pressure air conditioning systems: with constant and variable airflow rate; air to water air conditioning systems; induction unit; two pipes systems change over and no change over; three-pipe and four-pipe systems; hydronic systems with fan coil units; combination with ventilating systems, local air conditioning systems; compact and split systems; energy efficiency of ventilation and air conditioning systems.

**practical teaching**

Auditory is composed of more sections, in order to complete project design. Design and regulating air conditioning systems, calculating energy consumption and using waste heat. Laboratory consists of measuring airflow in ducts and distributive elements, regulating air conditioning systems, measuring airflow range and intermediate operating mode. Visit to Thermal science exhibition in HVAC congress or to factory for air conditioning equipment is planned.

**prerequisite**
In order to attend subject it is required to pass the exam: Fundamentals of Air Conditioning.

learning resources

Handouts

B. Todorovic, Air conditioning

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 15
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 50
requirements to take the exam (number of points): 21

references
Waste and wastewater management

ID: MSc-0125
responsible/holder professor: Jovović M. Aleksandar
teaching professor/s: Jovović M. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: written+oral
parent department: process and environmental protection engineering
semester.position: 3.3

goals

In this course, students will gain a solid basic and specific knowledge in the field of waste management and wastewater management. Laboratory exercises give students the opportunity to solve the various practical problems and perceive gained theoretical knowledge.

learning outcomes

Knowledge that students acquired about the specific technical solutions, the choice of methods of use waste and wastewater treatment equipment enabling the assessment of basic principles relevant for the design of these plants.

theoretical teaching

Characteristics, management, Legal basis and strategy, Systems of collection, Separation and treatment, Incidence and equipment for waste collection, transfer stations, transport, separation at source, recycling,
Thermal processing procedures, a biological waste treatment products using waste processing,
Criteria for disposal, problems, control and treatment of leachate, generation and use of landfill gas, waste management future - legislation, collection, incineration, disposal,
Hazardous waste, remediation of contaminated soil,
Water resource management, Technological (process) characteristics, Planning, Legislation, Political influences, Future challenges,
Water demands, Requirements for water quality, Sources of water supply, Water treatment, Transfer (transport), distribution and storage of water, needs and future development,
Water pollution, Waste water collection, Treatment principles, Treatment plants,
Role of public and government in controlling pollution, Trends in controlling water pollution.

practical teaching

Calculation of the waste growth, determining the required capacity for the collection, calculation of waste composition,
Selection and sizing of equipment for waste treatment,
Selection and sizing of equipment for the factory for processing of municipal solid waste,
Determining the basic size of the landfill and landfill gas generation calculations and possibility of its using,
Calculation of concentration and flow of pollutants in and efficiency of equipment for the wastewater treatment,
Calculation of material and heat balance of devices for wastewater treatment and calculation
of characteristic values,
Selection and sizing of equipment for wastewater treatment,
Examples of plants for biological wastewater treatment,
Experimental determination of heat and material balance of devices for pyrolysis of waste,
Determining the effectiveness of the air distributor in the aeration devices for biological wastewater treatment.

prerequisite

There are no requirements to attend courses, in terms of the previously passed courses.

learning resources

Considering that for the course is not yet completed a textbook, materials for lectures are submitted to students in printed and electronic form. Laboratory facility / installation / machine (LFI):
1. Laboratory testing facility for wastewater treatment
2. Laboratory plant for thermal waste treatment

number of hours

total number of hours: 45

active teaching (theoretical)

lectures: 18

active teaching (practical)

auditory exercises: 13
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 2
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 20
calculation tasks: 20
seminar works: 0
project design: 0
final exam: 50
requirements to take the exam (number of points): 27

references

Engine Design Project

**ID:** MSc-1023  
**responsible/holder professor:** Knežević M. Dragan  
**teaching professor/s:** Knežević M. Dragan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 2  
**final exam:** oral  
**parent department:** internal combustion engines  
**semester.position:** 3.3

**goals**

Gaining experience through practical work on the design of IC engines. The practical application of knowledge from previous IC engines courses, expansion and acquisition of new knowledge in the field of design and calculation of machines, materials and production methods of machine parts. Introduction to modern methods of design in mechanical engineering, especially in the field of IC engines. Understanding and gaining practical experience in working with computer aided design and calculation methods (CAD - 2D, 3D, CAE).

**learning outcomes**

Understanding the whole complex mechanical structures, the connection of individual parts and components, ability to design a functional and well-designed machines. The ability of practical application of modern software tools for designing in mechanical engineering. The capability to design, making good material and production methods selection of the most important parts of internal combustion engines. Selection and dimensioning of auxiliary systems and components needed for proper engine functioning.

**theoretical teaching**

The role of standardization and unification in the IC engine design. Phases of the classical approach to the design of the engine (sequential design). Definition of technical terms; Selection of the most important process and operating parameters in the construction of a new engine. Making of preliminary design and the main engine project. Preparation of workshop drawings. Testing and refinement of the prototype design; Simultaneous (parallel) design; Computer aided design; Technology of rapid prototyping; Mathematical modeling of working processes of Otto and Diesel-engine; Modeling of the fundamental elements of the Engine structure, the calculation by means of FEM.

**practical teaching**

Development of the project of the IC Engine - assembly drawings of the cross and longitudinal sections; 3D modeling (CAD) of one of the most important parts of the Engine and making workshop documentation for that part; Consultations in the preparation of the project.

**prerequisite**

Skills in using 2D & 3D CAD software
learning resources

- M. Cvetić: Extracts from lectures (handouts)
- 2D & 3D CAD CAE Software & Workstations

number of hours

total number of hours: 30

active teaching (theoretical)

lectures: 10

active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 70
final exam: 30
requirements to take the exam (number of points): 30

references
Aircraft maintenance

ID: MSc-1081
responsible/holder professor: Petrović B. Nebojša
teaching professor/s: Bengin Č. Aleksandar, Grbović M. Aleksandar, Dinulović R. Mirko, Mitrović B. Časlav, Peković M. Ognjen, Petrašinović M. Danilo, Petrović B. Nebojša, Svorcan M. Jelena
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: aerospace engineering
semester.position: 3.4

goals

Within the course “Aircraft maintenance” students will gain basic knowledge concerning contemporary theories and praxes in the maintenance and revitalization of both military and civil aircrafts. Furthermore, a part of the course is dedicated to exploration of maintainability, reliability of fighting tenacity, as well as the basic structural characteristics of the system that are defined in the early stages of design and development of modern aircrafts.

learning outcomes

After mastering the curriculum, students will be capable of creative thinking and decision making in the domain of aircraft maintenance. By gaining sufficient theoretical and practical knowledge, they will be able to participate equally in a working team designing or maintaining the aircraft and to further improve important flight characteristics such as reliability, maintainability, fighting tenacity or durability (particularly in cases of forced landings).

theoretical teaching


practical teaching


prerequisite
No specified conditions.

**learning resources**

Rasuo, B, Aero-technical safety, Serbian Military Headquarters, Belgrade, 2004;
Rasuo, B, Aircraft manufacturing technology, Faculty of Mechanical Engineering, Belgrade, 1995;
Additional materials (handouts, assignments etc.)

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 0
consultations: 10
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 10
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 15
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 55
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

**references**
Ecology of combustion

ID: MSc-1146

**responsible/holder professor:** Milivojević M. Aleksandar

**teaching professor/s:** Milivojević M. Aleksandar

**level of studies:** M.Sc. (graduate) academic studies

**ECTS credits:** 6

**final exam:** written

**parent department:** engineering materials and welding, tribology, fuels and combustion

**semester.position:** 3.4

**goals**

More than 90% of the world’s energy consumption is produced by combustion. It is expected that combustion will still be a prevailing method for energy production in the coming decades. On the other hand, having in mind that combustion is by far the biggest source of pollution, the goal of subject is to enable better understanding of the topic, train and qualify students to become competent experts in this field of international key importance.

**learning outcomes**

After successful finishing the course students should be able to:
- recognize and use modern technologies of the combustion processes,
- use techniques for reduction of emission of harmful and polluting combustion products,
- apply the acquired knowledge in combustion in the industry and energy sectors,
- work in research and development organizations.

**theoretical teaching**

Combustion basics. Conservation of mass and energy.
Specific topics on combustion of different fuels.
Combustion facilities and their performance.
Biofuels.
Co-combustion.
Emissions of polluting and harmful contaminants.
Role of CO2.
Technics to reduce emission of NOx.
Technics to reduce emission of SO2.
Technics to reduce emission of CO and HC.
Technics to reduce emission of particulates.
Technics to reduce emission of heavy metals
Technics to reduce emission of CO2.
CO2 trading.

**practical teaching**

Practical tuition includes analysis and examples of conservation of mass and energy laws regarding combustion and emissions. Examples of technics to reduce emissions of NOx and SO2 will be treated in particular. Measurements of flue gas emission components will be performed in a purpose built test stand. The effect of influencing parameters on emission performance of a purposely built burner will be experimentally performed and analyzed. A student will theoretically and numerically solve a problem of mass and energy balance of one
of pollution reduction techniques.

**prerequisite**

No conditions

**learning resources**

Subject Handouts

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 10
calculation tasks: 5
seminar works: 0
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 3
check and assessment of lab reports: 3
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 3
test, with assessment: 3
final exam: 3

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 10
calculation tasks: 20
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**
A. Milivojevic, Subject handouts
Principles of Combustion (Принципи сагоревања), Kenneth K. Kuo, BARNES & NOBLE
Energy certification of buildings

**ID:** MSc-0667  
**responsible/holder professor:** Todorović N. Maja  
**teaching professor/s:** Bajc S. Tamara, Todorović N. Maja  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** thermal science engineering  
**semester.position:** 3.4

**goals**

Acquiring knowledge and skills in the field of energy certification of buildings - the concept of energy building certificate, building energy consumption, energy needs and significant parameters; comfort conditions and design parameters, central heating and air conditioning systems, energy sources, final and primary energy, domestic hot water systems; optimization of HVAC systems and the application of passive techniques, methodology of calculation of indicators, classification of buildings by type and energy codes; elaboration of energy efficiency, energy certificate.

**learning outcomes**

Students acquire specific skills and knowledge in the field of energy certification of buildings; known methods for the calculation of indicators to determine the energy code of the building and can be applied in practice. Connects the basic knowledge and applies them to the elaboration of energy efficiency of the building and process of issuing energy performance certificate.

**theoretical teaching**

The concept of energy building certificate, Energy Performance of Buildings Directive – main objectives; building energy consumption, energy needs and significant parameters; comfort conditions and design parameters, central heating and air conditioning systems, energy sources, final and primary energy, domestic hot water systems; optimization of HVAC systems and the application of passive techniques, methodology of calculation of indicators, classification of buildings by type and energy codes; energy audit, elaborate of building energy efficiency, building energy certificate.

**practical teaching**

Auditory exercises consist of parts: Example of calculation of thermal properties of elements of the building envelope - the determination of the coefficient of thermal conductivity, specific transmission and ventilation losses, building shape factor, design conditions and schedules of use of technical systems, determination of energy needs and indicators that define the energy code; application measures to improve energy efficiency of buildings - individual measures and measure sets improvement, financial analysis.

Individual Project task – Elaborate on energy efficiency of building on the example of residential building.

**prerequisite**
No conditions

learning resources

M. Todorović: Energy certification of buildings - handouts

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 15
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 50
requirements to take the exam (number of points): 21

references

M. Todorović: Energy certification of buildings, handouts
Fundamentals of Mining and Construction Machines Dynamics

ID: MSc-0491  
responsible/holder professor: Bošnjak M. Srđan  
teaching professor/s: Bošnjak M. Srđan, Gnjatović B. Nebojša  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written  
parent department: material handling, construction and logistics  
semester.position: 3.4

goals

Basic course goals (objectives): 1) introducing students with specificities of dynamic processes of construction and mining machines. 2) mastering practical skills which are necessary for analysis of dynamic behavior of construction and mining machines.

learning outcomes

By successfully completing this course the student should acquire the following competences:
- Properly forming the reduced dynamic models of earthmoving machines such as single-bucket excavators and bulldozers;
- Determining elementary technical and exploitation characteristics of the machines used for material preparation and handling (rock crushers and sifters), accounting for dynamic effects occurring in such processes;
- Modeling the excitation of continuous excavators and analysis of the influence of constructional and working parameters of the machine on the excitation caused by resistance to excavation;
- Creating dynamic models of continuous excavators’ substructures;
- Identification and analysis of continuous excavators’ substructures response to excitation caused by resistance to excavation;
- Calculation and proper selection of basic parameters of conveyor belts with relatively high conveyor speed, dominantly used in mobile continuous earthmoving machines.

theoretical teaching


practical teaching

Dynamic models of single bucket excavator excavating devices. Impact of Bulldozer to the obstacle. Calculation of basic parameters of crushing and screening machines. Bucket wheel excavators and trenchers excitation modeling (determination). Analysis of bucket wheel excavators bearing structure dynamic response on excitation caused by resistance to

**prerequisite**

Required previously passed courses: Strength of Constructions, Structural and Stress Analysis, Mining and Construction Machines.

**learning resources**

1. Computers, Laboratory 516
2. Software Mathlab, Catia

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 20

**active teaching (practical)**

auditory exercises: 19
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 15
consultations: 5
discussion and workshop: 1
research: 0

**knowledge checks**

check and assessment of calculation tasks: 6
check and assessment of lab reports: 0
check and assessment of seminar works: 4
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 35
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 25
final exam: 30
requirements to take the exam (number of points): 35

**references**
Srđan Bošnjak, Bucket Wheel Trenchers, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, 2001.
Srđan Bošnjak, Handouts, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, 2008.
Srđan Bošnjak, Fundamentals of Mining and Construction Machines Dynamics, - Instructions for seminar paper realization, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, 2008.
Hybrid Technical Systems

ID: MSc-0966
responsible/holder professor: Miloš V. Marko
teaching professor/s: Miloš V. Marko
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: seminar works
parent department: general machine design
semester.position: 3.4

goals
Acquisition of general and basic knowledge of hybrid technical systems (HTS) as the most complex form of the TS, introduction to the structure and terms of HTS as a whole, the basic principles of the system components and the basic approaches to modeling and simulation.
To qualify students to understand the complexity of the procedures and systems integration through precise and detailed general methodology.
Developing skills of teamwork and networking skills in various fields.
Training for further study.

learning outcomes
Students will gain knowledge of some methods in engineering design, which will enable them to plan and implement complex processes of modeling, simulation and integration of hybrid technical systems (HTS).
The knowledge gained will be used in engineering practice to select the basic elements of various technical systems and linking design methods.
Being trained to be responsible teamwork.

theoretical teaching
Hybrid technical and technological systems: clarification and definition of the basic concepts, HT systems: fundamentals of design and development of HT systems, structures and basic elements; modularization and hierarchization.
Integration: functional, spatial, methods of designing and connecting various technical units; role of information technology, mechanical components and assemblies, electrical components and circuits, electronic components and sensors; Microcontrollers and Programmable Logic Controllers (PLC), Hydraulic components and assemblies; Pneumatic components and assemblies; Executive elements, Control, modeling and simulation of HT systems: computation and defining the behavior of the system as a whole and the interaction between the individual components, computer models and simulation systems; production processes as HT system: computer integrated manufacturing, product development process, automation; realization of various HT systems.
Implementation of 3D technology in verification of the elements HTS.

practical teaching
Exercises include presentation software packages and design packages for simulation and analysis. Also, an example (modeling and simulation) of relatively complex actuator systems (electro-mechanical actuator) as a representative of HT systems will be presented. Upon completion of the calculation and simulation, practical work with actuator: measurement of certain parameters and presentation of control; Three essays: HT system as a whole;
calculation and simulation EMA, HA or PA; modeling HT systems.
Verification of mechanical assemblies using the 3D printing.

prerequisite
None

learning resources
Moodle (Modular Object-Oriented Dynamic Learning Environment, open-source PHP web application for producing modular internet-based courses that support a modern social constructionist pedagogy).
Lectures, power point presentations, room equipped with computers & software for design and simulations, Laboratory for HTS, 3D printer, handouts.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 5
calculation tasks: 0
seminar works: 12
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 13
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 15
calculation tasks: 0
seminar works: 45
project design: 0
final exam: 30
requirements to take the exam (number of points): 45
references

Information integration of business functions 2

**ID:** MSc-0608  
**responsible/holder professor:** Mitrović B. Časlav  
**teaching professor/s:** Mitrović B. Časlav  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** information technologies  
**semester.position:** 3.4

**goals**

- Design and management of digital integrated business companies / factory, according to the business performance of integrated company,
- Acquiring knowledge, skills and competencies of the information and functional integration of the company,
- Integration of engineering, production and business activities
- Learn about the business performance of integrated company,
- Training to use commercial software for production management,
- Implementation of new information and communication technologies.

**learning outcomes**

The acquired knowledge to the student:
- Understand the operation of an integrated business enterprise / factory,
- Applies new information and communication technology,
- Critically observe production systems and business processes,
- Plans computerized activities, processes and systems,
- Approves new methods of learning and design,
- Develop cognitive traits of creative engineers in computer science,
- Participates in project teams of students and experts
- Is able to conduct business discussions with business partners.

**theoretical teaching**

Lesson 1
- Model information and functional integration of the company.  
- Model reference CIMOS ESPRIT's open architecture information and communication systems.

Lesson 2
- The cybernetic definition of business systems, business processes and business domains.  
- The pace and complexity of business systems and processes.

Lesson 3
- CIMOS functional entities and the transfer of information across levels of business.  
- Enterprise activities, functional operations and business events.  
- Integration of engineering, production and business activities.

Lesson 4
- Modeling for enterprise integration and a digital description of the business.
• Modeling of educational and business environment is an integrated enterprise.
• Functional analysis of systems and processes with the requirements for the synthesis of new designs.

Lesson 3
• Design of technical systems, products and technologies.
• The documentation and electronic exchange of information.

Lesson 6
• planning, (re) scheduling and execution of business operations.
• Optimal flow through the business sectors and facilities.
• Management and storage of materials throughout.

Lesson 7
• Information flow and integrated business tools.
• Reliability and track products through the life cycle.
• The software and integrated systems management company.

Lesson 8
• An integrated system of quality assurance.
• Procedures for quality.
• Quality standards.
• Integrated management levels (informational, operational, business, strategic).

Lesson 9
• Technology innovation in business.
• Cost management.
• Information and communication infrastructure is an integrated enterprise.
• Virtual Enterprise.

Lesson 10
• Business performance intelligent digital business enterprises.
• Business planning and development of competitive enterprises in the world market of goods, capital and knowledge.
• Software production management.
• Analysis of the results (outcomes) of learning objects.
• Preparation and instructions for the exam.

practical teaching

It consists of the auditory, laboratory exercises that accompany the course.
• Information integration of production and business enterprises.
• Systems for managing computer-integrated company activities.
• Business profile production companies.
• Information and functional integration of business enterprises.
• Students carry out professional training in an industry of Serbia or the professional excursion abroad.

prerequisite

Attended and passed the course at undergraduate level: Information integration of business functions or taking an entrance test.
learning resources

- Students are available to licensed software owned by the faculty.
- Students are available freeware software.
- Student must have a PC simplest configuration.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 2
laboratory exercises: 8
calculation tasks: 6
seminar works: 8
project design: 10
consultations: 4
discussion and workshop: 2
research: 0

knowledge checks

check and assessment of calculation tasks: 1
check and assessment of lab reports: 1
check and assessment of seminar works: 2
check and assessment of projects: 2
colloquium, with assessment: 2
test, with assessment: 2
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 15
laboratory exercises: 10
calculation tasks: 10
seminar works: 10
project design: 15
final exam: 35
requirements to take the exam (number of points): 35

references
Spasic, Ž., Information integration of business functions, Book, Mechanical Engineering, Belgrade
goals

The goal of intelligent vehicles and accordingly intelligent vehicle systems is to augment vehicle autonomous driving either entirely or partly for the purposes of safety, comfortability, and saving energy. The tasks of intelligent vehicles become more challenging due to dynamic change of complex environment perception and necessity for sensing, modeling and prediction of different influencing factors on the vehicle performance. Autonomous intelligent vehicles have to perceiving and modeling environment in order to control the vehicles. The vehicle motion control faces the challenges of strong nonlinear characteristics due to high mass, especially in the processes of high speed and sudden steering/braking. It needs processing, modelling and prediction non-linear changes in the vehicles system operation based on large amounts of data from multi-sensors and complex dynamic changes in an environment. Course objective is to provide an understanding the design and development process of intelligent vehicle systems and to develop students’ skills and knowledge in the area of intelligent vehicle systems development.

learning outcomes

Course outcomes are development of student’s abilities to: a) understand requirements being imposed to intelligent vehicle and its systems, assemblies, sub – assemblies, and parts, b) analyze the vehicle system operation and understand influences of the new intelligent solutions in the vehicle systems design on the vehicle overall performance and quality of use c) application of artificial intelligence techniques in development of intelligent solutions of the vehicle systems, d) analyze, understand and reconcile the new intelligent solutions in the vehicle system operation with legislation related to the specific vehicle systems and sub systems.

theoretical teaching

Theoretical lectures are divided into 7 sections:
1)Introduction – Intelligent vehicles and intelligent transport.
2)Monitoring and modeling of tire –road interaction.
3)Intelligent vehicle longitudinal control.
4)Intelligent vehicle lateral control.
5)Intelligent vehicle vertical control.
6)Intelligent vehicle vision systems.
7)Integrated intelligent control.

practical teaching

Students carry out a group-engineering project. Project is related to introduction of
intelligent solutions in the given vehicle system operation. Students have to:
1) critically analyze the design solutions of the given vehicle system.
2) identify possibilities for introduction of the system intelligent abilities.
3) model and predict the system performance based on artificial intelligence techniques
4) test the system intelligent solutions.
5) compare conventional and introduced intelligent system performance.

prerequisite

There is no precondition.

learning resources

Z. Miljković, D. Aleksendrić, Artificial neural networks-solved examples with theoretical background, Faculty of Mechanical Engineering University of Belgrade, 2009.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 30
requirements to take the exam (number of points): 30

references

R. Bishop: Intelligent vehicle technology and trends, © 2005 ARTECH HOUSE, INC.
Inustrial and Municipal Power Plants

**ID:** MSc-0914  
**responsible/holder professor:** Petrović V. Milan  
**teaching professor/s:** Banjac B. Milan, Petrović V. Milan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** thermal power engineering  
**semester.position:** 3.4

**goals**

The aim of the course is to provide a base of knowledge in specific applications of thermal power plants for combined production of electricity and heat in the industrial and utility of thermal energy. In scope of the development of modern thermal power generation, the applications of combined heat and power production is of growing importance due to the high primary energy savings. Exercise program consists in the development of computational tasks for modes of combined heat and power production based on the implementation of certain acquired practical knowledge of the course program.

**learning outcomes**

On completion of this programme, it is expected that student will be able to:

- select type of the steam turbine for production of electricity in industry,
- select type of the steam turbine for combined production of power and heat (CHP)
- conduct the feasibility study of introducing combined production of power and heat comparing to the separate production,
- perform thermodynamic calculation of backpressure turbine and condensing turbine for combined production of power and heat in nominal and off-design mode,
- calculation of operation of turbine stage at off-design loads,
- select a gas turbine for combined production of power and heat
- select organic Rankin cycle for use of waste heat.

**theoretical teaching**

The development and significance of combined energy production in the world. Thermodynamic effects and energy benefits of combined energy production compared to separate production of identical amount energy in power plants and heating plants. Types of thermal power plants for combined production of energy: steam power plants, gas power plants and combined gas-steam power plants. Factors influencing the choice of the type of thermal power plants for combined production of energy. Diagrams of heat consumption. The main thermodynamic parameters of combined energy. The influence of distance of consumer on choice of parameters and primary energy savings in the combined production. Types of steam turbine plants for combined energy. Steam power plants for combined production of energy. Methods of load regulation and operating flow characteristics or steam turbines. Diagrams of regimes for combined energy production.

**practical teaching**

Includes three tasks in the field of combined energy production. The first task related to condensing steam turbine power plant with regulated steam extraction. The second task is
related combined heat and power production with or without bypassing high pressure heaters in condensing steam turbine power plant with regulated steam extraction. The third problem relates to the definition of the diagram requires thermal heating consumption diagram and quality control requirements in the surface heat exchanger in substation of centralized heating system.

prerequisite

exams of steam and gas turbines.

learning resources

2. Rižkin, V.: Thermal power Plants Energoatomizdat, Moskva, 1987.-KSJ

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 6
laboratory exercises: 0
calculation tasks: 20
seminar works: 0
project design: 0
consultations: 4
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 5
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 5
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 20
seminar works: 0
project design: 0
final exam: 50
requirements to take the exam (number of points): 30

references

Kostyuk A., Frolov V.: Steam and Gas Turbines, Energoatomizdat, Moscow, 1988.-KSJ
Rižkin, V.: Thermal power Plants Energoatomizdat, Moskva, 1987.-KSJ
Stojanovic, Thermal Turbomachinery, Gradjevinska knjiga, Belgrade, 1967.
Machine tools M

**ID:** MSc-0920  
**responsible/holder professor:** Kokotović M. Branko  
**teaching professor/s:** Živanović T. Saša, Kokotović M. Branko  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** production engineering  
**semester.position:** 3.4

**goals**

1. To develop ability to perceive typical missions of machining systems.  
2. To study machine tools mechanisms and systems for their control and programming.  
3. To receive training in testing procedures for machine tools.  
4. To develop ability to analyze complex machine tools and machining systems equipment.  
5. The develop ability to analyze the resources for machine tools development.  
6. To study configuring and/or building of machine tools for planned mission.  
7. To receive training for realization of one mission of machine tools through writing the seminar work.  
8. To know how to make technical projects.

**learning outcomes**

Upon successful completion of this course students should be able to:

1. Recognize typical missions of manufacturing systems.  
2. Apply basic types of machine tool mechanisms in their design.  
3. Configure the control of CNC machine tools based on systems with open architecture.  
4. Program new generation machine tools using different programming methods.  
5. Evaluate the quality of machine tools and machining system based on applied standard test procedures.  
6. Configure machine tool for their own needs.  
7. Apply the acquired knowledge on the available resource for the development and / or improvement of machine tools and manufacturing systems.  
8. Prepare Technical Elaborate and reports about testing and programming of machine tools.

**theoretical teaching**

New teaching contents:  
1. AH-1 Consolidation of the curriculum for Machine Tools M.  
2. AN-2 Machine tools mechanisms.  
3. AN-3 Configuring machine tools.  
4. AN-4 Open-architecture machine tools control.  
5. AN-5 Object programming of machine tools.  
6. AN-6 Testing of machine tools and machining systems.  
7. AN-7 Complex machine tools.  
8. AN-8 Machine tools and machining systems equipment.  
9. AN-9 Resources for machine tools and machining systems development.

Extension:
1. AR-1 Extension of the theme AN-2 using the examples of support structures, guides, leading spindle etc.
2. AR-2 Extension of the theme AN-3: Methods of configuring new machine tools.
3. AR-3 Extension of the theme AN-4: The EMC2 System for machine tools control.
5. AR-5 Extension of the theme AN-6: Examples of complete procedures for testing machine tools.

**practical teaching**

1. Auditorial exercises:
   (1) Resources for studying machine tools. (2) Plan and program of laboratory exercises.
2. Laboratory exercises:
   (1) Machining system static stiffness. (2) Testing lathe accuracy. (3) Working accuracy of numerically-controlled milling machines. (4) Circular interpolation test, or, One combined testing of machining system.
3. Seminar work.

**prerequisite**

Study curriculum and student motivation for learning about machine tools and machining systems according to the goals set and outcomes offered.

**learning resources**

11. LPI-1: Three work places with manually controlled machine tools.
12. LPI-2: Three work places with numerically controlled machine tools.
13. LMS-1: The system for circular interpolation test.
14. LMS-2: The system for laboratory testing of machine tools accuracy.
15. LRS-1: One developmental work place with machine tool of the MOMA type.
16. LRS-2: One work place for testing machine tools mechanisms.
17. LPS-1: Work places for programming machine tool of the MOMA type.
18. APS-1: The system for experimental data acquisition and processing.
number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 3
laboratory exercises: 17
calculation tasks: 0
seminar works: 10
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 3
test, with assessment: 7
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 35
laboratory exercises: 15
calculation tasks: 0
seminar works: 20
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references

Mechatronics systems

**ID:** MSc-0342  
**responsible/holder professor:** Petrović B. Petar  
**teaching professor/s:** Petrović B. Petar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** production engineering  
**semester.position:** 3.4

**goals**

The aim of the course in mechatronics systems is to provide a focused interdisciplinary theoretical knowledge and practical experience for undergraduate students that encompass fundamental elements from traditional courses in mechanical engineering, production engineering, electronics and computer control engineering. These elements include sensors and measurement theory, digital systems and computation, semiconductor electronics, servoactuators and motion control, machine tools and robotics, altogether focused in deeper understanding of mechatronics aspects of modern manufacturing systems design, i.e., design of CNC machine tools, industrial robots and flexible production lines, based on contemporary numerical and computer control technology.

**learning outcomes**

1. Theoretical and practical knowledge how to design and select analog and digital circuits, microprocessor-based components, mechanical devices, sensors and actuators, so that the manufacturing equipment, i.e., machine tools, manipulating robots and manufacturing lines achieve desired function.
2. Deep understanding of basic principles of computer based numerical control systems and their application in machine tools, manipulating robots and industrial automation systems design.
3. Microcontroller programming and hardware design skills.

**theoretical teaching**

Theoretical teaching is organized in four teaching units:
1. Importance and role of mechatronics in modern manufacturing systems design,
2. Digital systems, microprocessors and microcontrollers – basic digital modules, arithmetic logic unit, microprocessor, machine and assembly language, microcontroller architecture and programming,
3. Sensory systems, signal conditioning, measurements and signal processing – working principles and design of sensors for force, displacement and speed measurement, signal conditioning based on semiconductor electronics, fundamentals of digital signal processing, vision sensors and systems, and
4. Electrical servo drives and motion control – stepper and dc motor fundamentals, servo drivers and numerically controlled servo axis, motion control and interpolation, CNC system architecture.

**practical teaching**

Practical training is organized through laboratory exercises and project of mechatronics system design in the field of manufacturing technology.
LAB 1: Microcontroller – demonstration of development system based on Microchip PIC16F87 microcontroller, hardware architecture, microcontroller programming in assembler language, application development using high-level programming languages (MicroPascal, MicroC), working with digital and analogue signals, digital interfaces and microcontroller networking;
LAB 2: Intelligent sensor systems in manufacturing – architecture of intelligent sensor system, design and operation of multi DOF force sensor based on strain gauge transducers, design and operation of laser triangulation sensor for highly accurate contactless displacement measurement, vision sensors and image analysis;
LAB 3: Servo drives and motion control – brushless dc servomotor, servo driver architecture and technical details, servo axis configuration and tuning, contour motion control - synchronization of two servo axes and demonstration of various kinds of interpolation algorithms, performances evaluation, demonstration of CNC system architecture and its building blocks.

Project: mechatronic system design using microcontrollers, microprocessor based sensory signal conditioning and processing, and servocontrolled actuators. The project is focused on specific problem closely related to real industrial scenarios.

prerequisite

Fundamental knowledge on Dynamics of mechanical systems, Electrical Engineering, Control Systems Eng., Cybernetics, and Computer programming skills

learning resources

[2] Handouts for each lecture. /In Serbian/;
[3] Instructions for writing laboratory reports /In Serbian/,
[4] Instructions and a referent example of the project /In Serbian/,
[5] Instructions for safe handling of laboratory equipment /In Serbian/.
[6] MatLab simulation system practical training in dynamic systems simulation and analysis,
[7] Development system based on Microchip PIC16 and PIC18 RISC microcontrollers for practical understanding digital computer organization and machine language,
[8] Compilers and High-level language development systems for Microchip PIC16 and PIC18 RISC microcontrollers (MicroC, MicroPascal),
[9] Peripheral modules for Microchip PIC16 and PIC18 RISC microcontrollers for practical trainings with digital and analogue signals, interfacing and networking and building human-machine interfaces,
[10] Force sensing demonstration and training installation (multy dof. strain gauge based sensors, signal conditioning and digital signal acquisition system),
[11] Noncontact displacement measuring 3d scanning system based on laser triangulation and structured light concepts; demonstration and training installation (sensory sistems, signal conditioning and digital signal acquisition system, digital signal processing and information extraction),
[12] Servo-axis demonstration and training test bead (servomotors, mechanical drive components, displacement measuring sensors (encoders), guiding system),
[13] Open architecture control system for motion control demonstration of servodriven systems, HMI and control code development system from CAD data
[14] Robot arms and mobile robot for students training in practical use of microcontrollers for different tasks in motion control of complex mechanical systems.
number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 6
laboratory exercises: 6
calculation tasks: 0
seminar works: 0
project design: 16
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 1
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 3
test, with assessment: 6
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 25
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 15
final exam: 40
requirements to take the exam (number of points): 30

references

Project Management & Air Regulation

ID: MSc-0142
responsible/holder professor: Mitrović B. Časlav
teaching professor/s: Mitrović B. Časlav, Petrović B. Nebojša
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: project design
parent department: aerospace engineering
semester.position: 3.4

goals

Course objective

• Understanding the importance of project management in aviation.
• The creation, introduction and use of aviation projects.
• Determining the functionality of your own projects.
• Preparation, analysis and project management.
• Understanding and preparing the necessary documents for the implementation of projects.

learning outcomes

The acquired knowledge enables the student to:
• Prepare, create and show their own skills,
• Determine the functionality of the aviation project,
• Prepare, perform and manage the development of the aviation project,
• Determine technology of designing an aviation project,
• Recognize the requirements of the local aviation industry in projects,
• Make the necessary documentation of aviation project,
• Implement and collect aviation project.

theoretical teaching

MODERN APPROACHES IN DESIGN (feasibility study, the methodology of improvement, modeling)
Project management (requirements, quality, time, cost, standards)
IMPLEMENTATION OF PROJECTS (initialization, implementation, monitoring and control, cost efficient)
SPECIFICS IN AIRCRAFT DESIGN (strategy in the region; aviation terminology)
WEIGHT AND PERFORMANCE REQUIREMENTS (zones on the aircraft, the speed limit requirements; flight performance)
Aviation law (aviation regulations, certification, airworthiness)
REGULATIONS REGARDING SECURITY (human factors, safety precautions, emergency procedures)
REGULATIONS OF MONITORING AND FLIGHT (planning, defining and tracking the flight operations manual, flight plan revision)
PRACTICAL CONSTRUCTION PROJECT (information gathering, development, simulation of project)

practical teaching

Parameter identification and selection of software for designing. Determination of technology

**prerequisite**

'defined curriculum of study program / modules'

**learning resources**

To cope with the case, it is necessary the use of textbooks, manuals for the project, a handout, Internet resources. IT equipment (hardware, CAD workstations, software (CAD, SSO, RRO) pcs. Equipment) ICT, available in the laboratory Aerotechnical Institute).

**number of hours**

**total number of hours:** 75

**active teaching (theoretical)**

lectures: 20

**active teaching (practical)**

auditory exercises: 6
laboratory exercises: 10
calculation tasks: 0
seminar works: 5
project design: 15
consultations: 0
discussion and workshop: 4
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 2
colloquium, with assessment: 0
test, with assessment: 3
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 15  
project design: 20  
final exam: 30  
requirements to take the exam (number of points): 35

references

Č. Mitrovic, Aviation regulations, textbook in preparation, full color, A4 format, Faculty of Mechanical Engineering  
Air Law , JAA - Joint Aviation Authorities, Theoretical Training Manual, Oxford, 2004  
Renewable energy resources - small hydropower plants

ID: MSc-0928
responsible/holder professor: Božić O. Ivan
teaching professor/s: Božić O. Ivan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: hydropower engineering
semester.position: 3.4

goals
Achieving academic competence in the field of small hydropower plants, hydromechanical equipment and hydro energy.
Obtaining practical knowledge in small hydropower plants designing and the content of the technical project documentation.
Mastering knowledge of how to choose and calculate hydromechanical equipment installed in small hydroelectric stations.
Developing the ability to find the optimal solution by combining a wide range of acquired theoretical and practical knowledge and using multicriteria methods.
Improving individual creative abilities in performing professional design of small hydropower plants.

learning outcomes
On successful completion of this course the students will be able to:
- define, plan and organize the phases of project design, build up and operation of small hydropower plants,
- apply the empirical data to the choice and calculation of hydraulic turbines and equipment (trash racks, valves, pipes etc.) with the aim of high efficiency operation of small hydro power plants,
- check the adopted geometry and operating characteristics by basic analysis of the transient operating regimes and water hammer phenomenon,
- collect, analyze and present the calculation results,
- choose the best solution to the specific case by analyzing more possible solutions from the point of energy efficiency,
- work as a part of a team as well as demonstrate their entrepreneurial skills.

theoretical teaching

practical teaching
The design phases and the accompanying technical documentation. Analysis of the input
data basis for the design. The basic parameters of SHPP. The calculation of main turbine parameters during designing process (dimensions of runner, spiral case, draft tube, suction head, reference level of turbine in relation to tail water level, minimum, nominal and maximum power). Turbines’ energy and cavitation characteristics. Turbine regulation and governing systems. Practical calculation examples from hydromechanical systems design. Additional systems in SHPP. Waterhammer calculation examples. Choice of types, number of pipelines and the pipes diameters. Trash rack and its cleaning mechanisms. Valve sample calculation. Determination of hydraulic measurements methods.

Demonstration of small Pelton turbine operation in the Laboratory of Hydraulic Machinery and Energy Systems. Visiting small hydro plants in the electric power systems.

prerequisite

It is desirable to have some of the BSc or MSc subjects on Hydraulic machinery and energy systems department passed or attended.

learning resources

Benisek, M.: Lecture handouts (Hydro-mechanical plants, Hydro-mechanical equipment)
Božić, I.: Hydraulic Turbines - Practical examples with extracts from theory, University of Belgrade Faculty of Mechanical Engineering in Belgrade, 2017
Bozic, I.: Auditory exercise handouts (Hydro-mechanical plants)
Laboratory for hydraulic machines and energy systems - devices and installations.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 14
laboratory exercises: 0
calculation tasks: 8
seminar works: 0
project design: 6
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 6
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5
assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 40
laboratory exercises: 0
calculation tasks: 0
seminar works: 25
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references

Бенишек, М.: Хидрауличне турбине, Машински факултет у Београду, 1998
Иван О. Божић „Хидрауличне турбине - Практични примери са изводима из теорије“, Машински факултет у Београду, 2017
Ристић Б., Милenkовић Д.: Мале хидроелектране-водне турбине, Научна књига, Београд, 1996
Selected topics in IC Engines 1

ID: MSc-1026
responsible/holder professor: Popović J. Slobodan
Teaching professor/s: Knežević M. Dragan, Miljić L. Nenad, Popović J. Slobodan
Level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
Final exam: project design
Parent department: internal combustion engines
Semester.position: 3.4

Goals

Acquiring new knowledge on role and importance of modelling dynamic processes in IC Engines. Broadening theoretical knowledge and analytical approach to thermodynamics, heat and mass transfer, fluid mechanics and fuel combustion by studying dynamic processes in IC Engine cylinder and collectors. Broadening knowledge and analytical approach to the mixture formation, fuel jet break-up, fuel droplet formation and evaporation. Broadening knowledge and skills in applied computational methods and modular programming. Developing practical skills to design model structures and apply numerical methods within project-oriented tasks related to IC Engines and HPS design and application.

Learning outcomes


Theoretical teaching

5. Mechanical losses in IC engines. Modelling engine friction and auxillaries power consumption. Experimental determination of mechanical losses distribution.
6. In-cylinder and port flow multidimensional modelling using CFD.
7. Selected topics in Engine exhaust and noise emission. Exhaust gas concentration modelling based on chemical reactions kinetics and chemical equilibrium. Exhaust gas emission measurement.
properties. Specific issues related to mixture formation and combustion of alternative fuels.


**practical teaching**

Literature and technical solutions survey and theoretical analysis. Development and application of numerical simulation models of engine processes, engine components or systems dynamic performance. System analysis by application of simulation models tailored to specific project-oriented task. Experimental verification. Reporting and results presentation.

**prerequisite**

Passed exam on course: IC Engines Processes

**learning resources**

Mathworks Matlab/Simulink IDE (Licenced)
AVL Advanced Simulation Tools (AST): Boost, Fire, Excite, Cruise
LMS AMESim
Laboratories equipped with IC Engine testing equipment (fully equipped IC Engine test benches)
DAQ Measurement equipment (National Instruments PXI based system with Labview Development software)

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 18
consultations: 2
discussion and workshop: 0
research: 10

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 10
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 70
final exam: 30
requirements to take the exam (number of points): 30

**references**

Selected books from premium publishers: Springer Verlag, Teubner, McGraw-Hill, Butterworth-Heinemann, Elsevier
Extensive selection of articles and papers: IMechE, SAE, JSAE, ASME, MTZ/ATZ, Elsevier etc.
Ship manoeuvring

**ID:** MSc-0958  
**responsible/holder professor:** Simić P. Aleksandar  
**teaching professor/s:** Simić P. Aleksandar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 2  
**final exam:** written  
**parent department:** naval systems  
**semester.position:** 3.4

**goals**

The aims of the course are to make the student familiar with:

1) Essential features of ship maneuverability so that the navigation is as safe as possible;
2) Standard tests and criteria for ship maneuverability estimation;
3) ITTC and IMO regulations;
4) Ship design in respect to its maneuverability (course keeping, turn ability, response to rudder deflection etc.).

**learning outcomes**

The student should know:

1) Basic features of ship maneuverability and criteria for its estimation;
2) To interpret regulations for maneuverability and to conduct maneuverability tests; 3) To know which measures should be undertaken in ship design to provide satisfactory ship maneuverability.

**theoretical teaching**

Theoretical teaching focuses on familiarizing the student with general principles of maneuverability, necessary mathematical formulations and stability criteria. Introduction of standard maneuverability tests (spiral and reverse spiral test, zig-zag maneuver, turning path, pullout test etc.). Captive and free running model tests (PMM, rotating arm technique etc.) are explained. Hydrodynamics of control surfaces (rudders) follows.

**practical teaching**

Practical teaching focuses on the application of knowledge to common engineering practice. Practical explanations are given for performing standard maneuverability tests. Students are familiarized with active (bow thrusters, azimuth thrusters, etc.) and passive control devices (various types of rudders). Recommendations are given for ship design and meeting the criteria defined by IMO regulations.

**prerequisite**

There are no prerequisites.

**learning resources**

Lectures are available in electronic form
A detailed prominent example of the manoeuvring tests
Brochures of various equipment manufacturers
Internet resources

**number of hours**

total number of hours: 30

**active teaching (theoretical)**

lectures: 12

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 1
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 45
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 50
requirements to take the exam (number of points): 25

**references**

Software application in Ship design

**ID:** MSc-1019  
**responsible/holder professor:** Kalajdžić D. Milan  
**teaching professor/s:** Kalajdžić D. Milan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 4  
**final exam:** written  
**parent department:** naval systems  
**semester.position:** 3.4

**goals**

To cover the application of computer program packages for ship design and basic ship calculations.

**learning outcomes**

Practical knowledge in applying computer programs for developing ship form, hydrostatic computations, power prediction, hull structure scantling, seakeeping and ship design.

**theoretical teaching**

Concepts and basic aspects of the application of computer programs and commercial software packages for shipbuilding. Some basic software packages connected to ship geometry, lines drawing, hydrostatic computations, hull construction, power prediction, ship manoeuvring and seakeeping are explained and demonstrated.

**practical teaching**

Students are trained to work with available software packages, in order to solve practical engineering problems of ship geometry, lines drawing, hydrostatic computations, construction, power prediction, manoeuvring and seakeeping. The course is parallel to the Ship Design, and the students use the software for developing their individual ship design project.

**prerequisite**


**learning resources**

[1] Extracts from lectures (handouts) /In Serbian/  
[3] Internet resources

**number of hours**

Total number of hours: 45

**active teaching (theoretical)**
lectures: 18

**active teaching (practical)**

auditory exercises: 0  
laboratory exercises: 18  
calculation tasks: 0  
seminar works: 0  
project design: 0  
consultations: 0  
discussion and workshop: 0  
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0  
check and assessment of lab reports: 4  
check and assessment of seminar works: 0  
check and assessment of projects: 0  
colloquium, with assessment: 0  
test, with assessment: 0  
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10  
test/colloquium: 0  
laboratory exercises: 60  
calculation tasks: 0  
seminar works: 0  
project design: 0  
final exam: 30  
requirements to take the exam (number of points): 30

**references**

DELTshipTM user manual  
AutoCAD user manual
Technical and Technological Development and Innovation Activity

ID: MSc-0585  
responsible/holder professor: Stevanović D. Vladimir  
teaching professor/s: Nedeljković S. Miloš, Sedmak S. Aleksandar, Stevanović D. Vladimir  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written+oral  
parent department: thermal power engineering  
semester.position: 3.4

goals

The aims of the subject are mastering the methods for the planning and conducting technical and technological development and innovative project, as well as acquiring knowledge in the corresponding fields, such as intellectual property, patent rights, legal regulations, economic evaluation of innovative projects etc.

learning outcomes

Students acquire knowledge about development mechanisms of technical, technological and innovative development, methods for planning, control and conducting of development projects and research, about economic evaluation of investment, intellectual property, patent and production rights.

theoretical teaching


practical teaching


prerequisite

Passed at least one exam at the module.
learning resources

Lecture handouts, articles from technical and scientific journals, national and international acts, directives and law regulations.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 8
consultations: 6
discussion and workshop: 6
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 3
test, with assessment: 2
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 35
final exam: 30
requirements to take the exam (number of points): 35

references
The law of industrial property, Society of engineers and technicians of Yugoslavia, Belgrade, 1990.
Techno-economic analysis of projects

ID: MSc-1042
responsible/holder professor: Dondur J. Nikola
teaching professor/s: Dondur J. Nikola
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: industrial engineering
semester.position: 3.4

goals

The objectives of this course are to guide students in engineering and the respective economic and financial processes and to inform them of the relations, connections and rules by which these processes take place in the generation and selection of optimal variant of projects for the overall success in achieving development goals of enterprise.

learning outcomes

Upon successful completion of this course, students would need to be able to:
- Apply methods of evaluation of investment projects,
- Rank investment alternatives,
- Carry out an analysis of the sensitivity and criticality of investment projects,
- Carry out assessment of the risk investment alternatives.

theoretical teaching

Introduction to analysis and evaluation of the effectiveness of projects; contents of the investment study; analysis of the solvency of company-investor; market analysis; analysis of technical and technological aspects of investment; analysis of organizational and managerial aspects of investment; ecological analysis and economic-financial analysis.
Time value of money; methods of calculating interest and the calculation of interest formula.
Depreciation - types of depreciation, methods of calculating depreciation.
Cost Analysis - classification of costs from an engineering standpoint.
A concrete analysis of projects: analysis of operational, investment and financial activities of the project; the influence of inflation and risk on project analysis.

practical teaching

1. auditory exercise: recovering material from the first hours of lectures with detailed analysis of contents of the investment study.
2. auditory exercise: technical, technological and ecological aspects of the project and
1. computational practice: tasks of the time value of money and the NPV method.
2. computational practice: tasks of the annual equivalent worth method.
3. computational practice: tasks of the IRR.
4. computational practice: tasks of the MAPI method and depreciation.
5. computational practice: tasks of cost analysis.
6. computational practice: tasks of analysis of operational, investment and financial activities of the project and analysis of projects under the influence of inflation.
7. computational practice: tasks of analysis of projects under the influence of risk.
prerequisite

The student must be enrolled in the first year of academic studies (the second semester).

learning resources

1. Handouts

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 8
laboratory exercises: 0
calculation tasks: 16
seminar works: 0
project design: 0
consultations: 6
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 4
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 6
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 35
laboratory exercises: 0
calculation tasks: 30
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references
Park, Ch: Contemporary Engineering Economics, Addison-Wesley Publishing Company, 1993.;
Young, D.: Modern engineering economy, John Wiley & Sons, 1993.;
Tribology

ID: MSc-0519
**responsible/holder professor:** Vencl A. Aleksandar
**teaching professor/s:** Vencl A. Aleksandar
**level of studies:** M.Sc. (graduate) academic studies
**ECTS credits:** 6
**final exam:** oral
**parent department:** engineering materials and welding, tribology, fuels and combustion
**semester.position:** 3.4

goals

The student attending this course should:
- Comprehend the significance of friction, wear and lubrication (tribology keywords) and the problems connected with it, the field of construction and maintenance of mechanical parts and systems;
- Master the fundamental knowledge in these areas of tribology in order to decide the merits of the choice of materials and lubricants for the construction and tribological components;
- Solve problems related to the prevention of wear and competently decide on techniques to improve tribological properties of materials and lubrication technologies.

learning outcomes

Based on the mastered knowledge the student is qualified to:
- Identifies and critically analyze the basic causes of energy and material dissipation in some mechanical system;
- Recognize the dominant type of wear in some mechanical system and to propose appropriate measures for its reduction;
- Choose the appropriate type of material for the basic tribological elements (plain bearings, roller bearings and gears);
- Describes and distinguishes the most common surface modification and coating deposition methods;
- Explain the influences of temperature and pressure on the value of the viscosity (lubricants rheology);
- Describes and distinguishes the basic types and methods of lubrication with their characteristics.

theoretical teaching

- Tribology as a science and technical disciplines and techno-economical importance of tribology.
- Properties of surfaces and the nature of contact of two bodies.
- Friction – the basic causes and principles; Friction of metals and non-metals.
- Wear – mechanisms and types; Wear calculation and measuring methods; Wear prevention.
- Tribological materials (types and application in tribology); Characteristics and selection of materials for tribological components.
- Technologies for improving the tribological properties of materials (surface modifications and coatings).
- Lubricants – role, type, classification and basic properties; Rheology of lubricants.
- Forms and types of lubrication; Hydrostatic, hydrodynamic, elastohydrodynamic and boundary lubrication.
• Lubrication systems (tasks and roles; procedures and classification; elements definition) and lubricants selection.
• Lubrication services organization and lubricants ecology.

practical teaching

• Tribological losses in the industry and transportation; Tribological improvements studies.
• Characterization of the tribological surfaces; Methods and apparatus for surface roughness measuring; Surface roughness standards; Influence of material processing and machining on the surface roughness; Properties of surface layers.
• Presentation of worn surfaces and machine parts failure due to wear, and wear products (debris).
• Examples of different solutions for improving the tribological properties of materials.
• Laboratory practice: “Experimental evaluation of roughness, friction and wear”; Measuring of roughness and coefficient of friction and wear values for different materials and test conditions.
• Classifications and specifications of lubricants; Methods for lubricants testing.
• Laboratory practice: “Experimental investigation of the rheological properties of lubricants”; Determination of the rheological properties of lubricating oils (viscosity, viscosity-temperature dependence, viscosity index) and greases (shear stress and shear rate gradient, apparent viscosity).
• Essay writing.

prerequisite

No special requirements.

learning resources

1. --, Handouts for each lecture.
5. Pin-on disc tribometer; Block-on-ring disk tribometer; Four Ball machine.
6. Viscometer for liquid lubricants; Pressure grease viscometer.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 12
calculation tasks: 0
seminar works: 5
project design: 0
consultations: 13
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 2
check and assessment of seminar works: 4
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 4
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 45
laboratory exercises: 10
calculation tasks: 0
seminar works: 10
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

**references**

Urban and special rail vehicles

ID: MSc-1191
responsible/holder professor: Milković D. Dragan
teaching professor/s: Milković D. Dragan, Simić Ž. Goran
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: railway mechanical engineering
semester.position: 3.4

goals

1. Understanding the specifics of urban rail vehicles.
2. Understanding the various types of special rail vehicles.
3. Qualification for the application of acquired knowledge in the design, development, repair and maintenance of urban rail vehicles and special vehicles

learning outcomes

After completion of the course the student should be able to:
1. Explain the functional and design specificity of various types of urban rail vehicles.
2. Explain the tasks and functionality of various types of special rail vehicles.
3. Explain the specific technologies and technical requirements in combined transport.
4. Apply appropriate regulations and standards in the design and maintenance of urban rail vehicles and special rail vehicles.

theoretical teaching

Special wagons: tank-wagons, refrigerating wagons, hopper wagons, articulated multiple wagon units...- technical requirements and technical solutions.

practical teaching

Division and classification of the transport units for combined transport: pallets, containers, swap bodies. Stability during loading or unloading of wagons with horizontal transshipment.
The determination of the gauge code for semi-trailers in combined transport by rail. Analysis of the design parameters of the wagons for the combined transport.
Dimensioning requirements of the tanks by RID regulations. Valve system variants of the tanks for the transportation of the dangerous goods.
with small radius. Design examples of the unconventional rail systems. Design concepts of the magnetic levitating vehicles.

**prerequisite**

Previously passed exam of Railway cars 1 or Theory of traction.

**learning resources**

Simic, G., Urban and special railway vehicles, hand-out
EN standards, UIC and RID regulations from the subject field.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 12
laboratory exercises: 0
calculation tasks: 4
seminar works: 3
project design: 0
consultations: 6
discussion and workshop: 5
research: 0

**knowledge checks**

check and assessment of calculation tasks: 4
check and assessment of lab reports: 0
check and assessment of seminar works: 2
check and assessment of projects: 0
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 50
laboratory exercises: 0
calculation tasks: 10
seminar works: 10
project design: 0
final exam: 30
requirements to take the exam (number of points): 40

**references**
Aeroelasticity

**ID:** MSc-0645  
**responsible/holder professor:** Dinulović R. Mirko  
**teaching professor/s:** Dinulović R. Mirko, Simonović M. Aleksandar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** aerospace engineering  
**semester.position:** 3.5

**goals**

1. introduction to modern aeroelasticity problems and their analysis and practical methods to solving aeroelasticity problems in real aircraft structures  
2. introduction to experimental dynamic analysis of aircraft structures  
3. introduction to dynamics of thin walled structures

**learning outcomes**

After successful competition of the course students should be able to:

1. Determine forms of oscillation of thin walled structure  
2. calculate the torsional divergence speed of lifting surface  
3. Calculate the command reversal speed ( ailerons ) on the wings  
4. Estimate flutter speed of the lifting surface using Teodorsen method  
5. Generate finite element models of lifting surfaces of the aircraft for static and dynamic aeroelastic analysis .

**theoretical teaching**

In the theoretical part of the course following topics are covered: Introduction to aeroelasticity. Types of aeroelastic phenomena on aircrafts and structures in general. Static, dynamic aeroelasticity. Differential equations and solution methods. Galerkin’s method, collocation at the point, collocation at subdomain. Oscillations, types, mathematical models. Wing divergence, Command reversal, Flutter. Oscillations of continual distributed mass.

**practical teaching**

During practical part of the course covered topis in theoretical part are demonstrated in practice. Typical practical problmes are analyzed through numerical examples. Students are required to complete practical project work using computer modeling and analysis. All required material is available in the form of lecture notes, books and past exams and tests.

**prerequisite**

Mathematics, Resistance of materials

**learning resources**

Computing Laboratory for Theory of elasticity and Aeroelasticity
number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 5
seminar works: 0
project design: 10
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 5
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 10
seminar works: 0
project design: 20
final exam: 40
requirements to take the exam (number of points): 40

references

An introduction to the theory of aeroelasticity, Y.C. Fung, Dover publication
Aircraft armament systems

**ID:** MSc-1082  
**responsible/holder professor:** Simonović M. Aleksandar  
**teaching professor/s:** Peković M. Ognjen, Svorcan M. Jelena, Simonović M. Aleksandar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** aerospace engineering  
**semester.position:** 3.5

**goals**

The study of this course is to ensure adoption of procedures and methods for problem solving related to aircraft armament calculations. Students will be capable of independently study aircraft rocket, bomber and firearms armament elements in order to obtain maximum effectiveness for the given conditions of application for each of these types of aircraft weapons. Particular attention will be faced towards development trends of modern aircraft armament.

**learning outcomes**

By mastering of the course curriculum student obtains following subject - specific skills:

- thorough knowledge and understanding of different types of aircraft weapons and their application  
- calculation of air weapons characteristics and possibility of their integration into the aircraft with the use of scientific methods and procedures  
- linking basic knowledge in mathematics, programming, mechanics and fluid mechanics and their application in design and calculation of aviation weapons and its integration;

**theoretical teaching**

- Introduction to aircraft armament field - Division and classification - Historical development - Development trends - Aircraft bomber armament - Determining the actual coordinates of the aim - Aerodynamic integration of bombs, carriers and aircraft - Underslung load influence on aircraft characteristics - Aircraft underslung load removal calculations - Trajectory stabilization - Determination of forces and moments on the underslung loads - Parachutes and braking devices - Aircraft missile systems - The basic components of missiles and their arrangement - Structure calculations and structure types - Slender bodies aerodynamic characteristics - Aerodynamic interference - Steering elements design features - Stability derivatives - Damping of the pitching and rolling - Firearms - Definition and division of firearms - The basic components and mechanisms - Determination of forces and loads - Dynamics and shock in the automatic mechanisms, equipment and parts - Existing solutions of integration - Depreciation recoil force in accordance with the construction of aircraft - Connections in aircraft - container system.

**practical teaching**

- Division and classification of aircraft armament - Aircraft bomber armament, air bombs classification - Aerodynamic bombs, carrier and aircraft integration - Stabilization path - Parachutes - Aircraft missile armament - Missile classification - Design characteristics - Aerodynamic schemes - The basic components of missiles and their rearrangement - Rocket
structure and construction calculation - Aerodynamic interference - Steering elements design features - Stability derivative - Aircraft firearms - Firearms definition and division - The main components and mechanisms - Determination of forces and loads - Dynamics and shocks in the mechanisms - Existing integration solutions - Depreciation recoil force

**prerequisite**

There is no necessary requirement for attendance of Aircraft Armament.

**learning resources**

1. Jankovic S. Aerodinamika projektila, Faculty of Mechanical Engineering, Belgrade, 1979, КДА (in Serbian)
2. Additional materials (written handouts, problem setting, guidelines for problem solving), DVL

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 10
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 60
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

references

Jankovic S. Aerodinamika projektila, Faculty of Mechanical Engineering, Belgrade, 1979,КДА (in Serbian)
Combustion appliances

**ID:** MSc-1147  
**responsible/holder professor:** Milivojević M. Aleksandar  
**teaching professor/s:** Milivojević M. Aleksandar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** engineering materials and welding, tribology, fuels and combustion  
**semester.position:** 3.5

**goals**

The objective of this course is to provide students with general appliances that use combustion methods.

**learning outcomes**

To teach and enable students to understand general combustion appliances and use the knowledge in industrial and energy sectors.

**theoretical teaching**

The combustion appliances include burners, burner systems, combustors, furnaces and control systems. Different types of burners including diffusion, atmospheric, premixed with natural and force aerated, porous and thermal radiation types. Mixture preparation for liquid, gaseous and solid fuel types, flame stabilization methods, standards, safety systems.

**practical teaching**

Displaying techniques for controlling the operation of various combustion devices.

**prerequisite**

No preconditions for attendance

**learning resources**

Subject Handouts.

**number of hours**

**total number of hours:** 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10  
laboratory exercises: 5  
calculation tasks: 5  
seminar works: 5
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 2
check and assessment of lab reports: 2
check and assessment of seminar works: 3
check and assessment of projects: 0
colloquium, with assessment: 2
test, with assessment: 3
final exam: 3

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 20
seminar works: 10
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**

A. Milivojevic, Subject handouts
Principles of Combustion (Принципи сагоревања), Kenneth K. Kuo, BARNES & NOBLE
Computational Fluid Mechanics

ID: MSc-0941
responsible/holder professor: Ćoćić S. Aleksandar
teaching professor/s: Ćoćić S. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: fluid mechanics
semester.position: 3.5

goals

Student should gain basic theoretical knowledge and principles of computational fluid dynamics (CFD), to be able to perform basic numerical calculations by using CFD methods, and to learn to use open-source CFD software OpenFOAM.

learning outcomes

Upon successful completion of the course, students will be able to:
- explain the general principles of numerical solution of governing equations for fluid flow
- explain and apply finite difference and finite volume methods for discretization of governing equations for fluid flow
- explain and apply principles of numerical grid generation
- use Python programming language for solution of modeled equation of fluid mechanics (1D and 2D heat equation, 1D wave equation, Burgers equation)
- use OpenFOAM solvers for determining the solution of 3D Laplace and convection-diffusion equation, and laminar incompressible flow in various domains
- explain general principles in turbulence modeling and apply turbulence models in OpenFOAM on specified cases of turbulent flow

theoretical teaching


practical teaching


prerequisite

Passed exams: Fluid Mechanics B and Numerical Methods, and Fluid Mechanics M (not obligatory, but it’s will be easier to follow the lectures).

learning resources

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 25

active teaching (practical)

auditory exercises: 10
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 5
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 10
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 50
final exam: 40
requirements to take the exam (number of points): 0

references

Versteeg H., Malalasekera, An Introduction to Computational Fluid Dynamics - The Finite Volume Method, Pearson Prentice Hall
Computer Control and Monitoring in Manufacturing Automation

**ID:** MSc-0787  
**responsible/holder professor:** Petrović B. Petar  
**teaching professor/s:** Bojović A. Božica, Petrović B. Petar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** production engineering  
**semester.position:** 3.5

**goals**

Acquisition of knowledge about the application, design and introduction of modern computer control systems and supervisory into manufacturing automation. Skill development for solving computer control and supervisory problems by using computer, information and control technologies and adequate scientific methods.

**learning outcomes**

The student should:
1. Understand the principles, place and role of the computer control system and supervising in manufacturing automation, link knowledge of related subjects to apply it to control and supervising in manufacturing automation;
2. Master scientific methods of analysis, synthesis, design and introduction of computer control systems in manufacturing automation;
3. Know practical problem-solving and how to apply computer technology and modern control systems in control and supervising in manufacturing automation.

**theoretical teaching**

2. CNC control. Functions, hardware, software, mathematical models. Main and auxiliary movement control, interpolation and internal calculations. Control panel and workshop programming. Communication functions.  
3. Programmable controllers. Functions, hardware, software, input/output modules. Programming languages and programming techniques according to the IEC 61131 standard.  
4. SCADA systems. Functions, hardware, software. Data acquisition, man-machine interface, programming and algorithms in control and monitoring.  
5. Sensors and actuators in control and supervising. Remote and intelligent terminal units.  

**practical teaching**

1. Auditorial exercises: Tasks in control design and supervising in manufacturing automation, with programming and control scheme design.  
2. Laboratory exercises: Design of examples for control and supervising in manufacturing automation and their practical realization in laboratory conditions, with the use of modular robots and computer-based control systems, CNC control, programmable controllers, robot controllers and SCADA software, with programming.
3. Project: Design of examples for control and supervising in manufacturing automation, with programming.

**prerequisite**

Defined by curriculum of study program.

**learning resources**

1. Pilipović, M. Control and monitoring in manufacturing automation - Handouts, FME, Belgrade, 2011, DVL
2. Pilipović M., Manufacturing processes automation: Laboratory, FME, Belgrade, 2006, PRA. /In Serbian/
3. Lab desk with pneumatic, electro-pneumatic and electric components and programmable controllers, Lab for manufacturing automation, EOP/LRS.
4. "Pick and Place" electro-pneumatic modular robots with programmable controllers, Lab for manufacturing automation, EOP/LPI.
5. Programming computers, Lab for manufacturing automation, IKT/PPC.
6. Software for programmable controller programming, Lab for manufacturing automation, IKT/RRO.
7. Communication network of computers and programmable controllers, Lab for manufacturing automation, IKT/KIO.
8. CNC and robot controllers, Lab for machine tools, EOP/LPI
9. SCADA software for supervising and programming, Lab for manufacturing automation, IKT/RRO.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 8
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 2
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 4
check and assessment of seminar works: 0
check and assessment of projects: 2
colloquium, with assessment: 0
test, with assessment: 4
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5

test/colloquium: 20

laboratory exercises: 15

calculation tasks: 0

seminar works: 0

project design: 20

final exam: 40

requirements to take the exam (number of points): 36

**references**


Computer simulations of thermalhydraulic processes and CFD

**ID:** MSc-0153  
**responsible/holder professor:** Stevanović D. Vladimir  
**teaching professor/s:** Milivojević S. Sanja, Stevanović D. Vladimir  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** thermal power engineering  
**semester.position:** 3.5

**goals**

The aim is acquiring knowledge and skills for development and application of analytical and numerical models of thermal-hydraulic processes in energy, thermal and process equipment, as well as application of numerical methods for the simulation and analyses of one-phase and two-phase systems in pipelines and plant equipment, including the methods of Computational Fluid Dynamics - CFD.

**learning outcomes**

The students are trained to perform computer simulation and analyses of heat transfer and fluid flow processes of one-phase and two-phase gas-liquid systems with and without phase transitions in energy, thermal and process equipment.

**theoretical teaching**

Modelling of thermal and flow processes with lumped and distributed parameters. Balance equations of mass, momentum and energy and constitutive correlations for interface transfer processes. Explicit and implicit numerical methods for the solving of Cauchy problems with defined initial conditions in cases of the lumped parameter models. The method of characteristics for the solving of hyperbolic system of partial differential equations. The application of the method of control volumes of the SIMPLE type for the solving of elliptic and parabolic multidimensional models with distributed parameters. Numerical grid generation. Graphical presentation of results.

**practical teaching**

Development of the models with lumped parameters for the pressure dynamics prediction in the pressurized vessels filled with one phase compressible fluid or two-phase mixture of liquid and condensing vapour. Numerical simulation of pressure transients in the pressurizer, in the feedwater tank and the drum of a steam boiler. Development of models with distributed parameters for one-phase and two-phase flows with or without phase transitions. Numerical simulations of pressure and temperature waves propagation in pipeline networks. Computer simulations and analyses of multidimensional two-phase flows in steam generators, evaporators, condensers, heat exchangers, etc.

**prerequisite**

Attended courses in Fluid Mechanics, Thermodynamics, and Numerical Methods.

**learning resources**
Course handouts.

Computer equipment.
Software for numerical solving of systems of differential equations of various types.
Software for simulation and analyses of pressure transients in pipeline networks and pressurized vessels.
Software for simulation and analyses of multidimensional two-phase flows.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 5
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 30
laboratory exercises: 35
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**
Stevanovic, V., Thermal-Hydraulics of Steam Generators – Modelling and Numerical Simulation, University of Belgrade, Faculty of Mechanical Engineering, 2006.
Forensic Engineering

ID: MSc-0876
responsible/holder professor: Popović M. Vladimir
teaching professor/s: Popović M. Vladimir
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: motor vehicles
semester.position: 3.5

goals

Student is enabled to apply forensic engineering methods, particularly in the area of motor vehicles, which comprises analyses and reconstruction of road accidents, vehicle damage estimation and vehicle value estimation based on case study principles. Analogous methods will be applied in other field of mechanical engineering, depending on the interest of students.

learning outcomes

Upon successful completion of this course, students should be able to:
- explain the concept of forensics and forensic engineering, with respect to vehicles;
- define and analyse technical system failures, their causes and effects, with a special emphasis on the application in automotive field;
- identify and analyze the causes of traffic accidents in which vehicles participated, with elements of investigation and reconstruction;
- make estimate of the damages on the vehicle and its value, on the case study principles;
- define the technology of the damages assessment and the cost of revitalization (repair) of the vehicle/system;
- analyze adequate technical solutions and conditions under which accidents might be avoided.

theoretical teaching

Organized in blocks.
First Block: general knowledge of forensics and forensic engineering, i.e. technical systems failure analyses, their causes and consequences, with a particular emphasis on the area of automotive engineering.
Second Block: Vehicle condition changes and value estimation methods
Third Block: Vehicle and component failures, i.e. accidents causing vehicle damage
Fourth Block: Vehicle damage estimation techniques and repair costs
Fifth Block: Analyses of road vehicle accident causes and consequences, with the elements of accident site investigation and evidence collection, including accident reconstruction.

practical teaching

Organized in two forms, as listening exercises aiming to enable preparation for working on case studies and in the form of seminar assignments within which each student will individually resolve the subject relevant cases on the basis of case study methodologies. Student are provided with real data about vehicle (or other technical systems of interest) accidents, and they will study the causes and the consequences of such accidents or the causes of damage of these systems, in particular they will analyze why an accident happened.
and what possibilities there are to avoid it. A particular attention will be payed to estimation of conditions under which such an accident might be generally avoided, but also in the particular case.

**prerequisite**

No special requirements.

**learning resources**

1. Class room
2. Other author book
3. Foreign language books
4. Other literature
5. IT Hardware
6. IT software

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 0
seminar works: 15
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 10
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 60

references

Lecturing handouts
Gearbox Reliability

ID: MSc-1096
responsible/holder professor: Ristivojević R. Mileta
teaching professor/s: Ognjanović B. Milosav
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: general machine design
semester.position: 3.5

goals

To develop students ability for recognition mechanical power transformation taking in consideration service resistance probability and failure probability of transmission unit components. Introduce students with calculation methodology of elementary reliability in relation of expected failure of transmission unit component as well as the total reliability of the unit. Recognize difference in reliability identification for design of the system and for maintenance. Intake students in design procedure (design parameters selection) based on limited reliability as design constraint. Selected design parameters have to provide maintain of necessary reliability level in the course of transmission unit exploitation

learning outcomes

After successful completion of this course, students should be able to:
• Select and develop propulsion systems based on the probability of service conditions.
• Identify, assess and create the load spectra of service conditions in the course of exploitation.
• Analyze the damages of components based on fatigue damage accumulation and operating endurance for certain operating conditions.
• Apply procedures for experimental tests of failure probability of components (gears, bearings, shafts, etc.).
• Determine (calculate or estimate) the reliability for design of the components in relation to certain damage and design parameters selection in accordance with the required level of reliability.
• Harmonize the design parameters to lower level of dynamic excitation and emission of vibration and noise

theoretical teaching

Mechanical power transformation, types of transmission units, types of mechanical transmission units, conceptual and design solution; Service load probability, load spectrums, regimes of service, experimental identification; Endurance of transmission components for experimental conditions (fundamental endurance); Fundamental endurance transformation into service endurance according to load spectrum by application of fatigue damage accumulation; Failure probability in the range of finite fatigue life, infinite fatigue life and in the range of service endurance; Elementary unreliability of transmission unit components (gear pairs, bearings, couplings,.....); Reliability of train transmission system and inverse reliability identification of components; Design parameters identification based on axiomatic and robust design.

practical teaching

756
Numerical examples exercise following lectured content. Examples include the practical realization of the acquired theoretical knowledge. Project task contains design development of transmission unit with working out of drawings. For selected gear unit components (gears, bearings, etc..), project involves calculation of the elementary reliability in relation to potential failures as well as defining the structure of the reliability of complete gear unit.

**prerequisite**

It is no conditions.

**learning resources**

Books - Textbooks:
Ognjanović M: Innovative development of technical systems (Chapter 4. Selected properties for the design of technical systems) - University of Belgrade, Faculty of Mechanical Engineering 2014.
Ognjanović M: Machine elements - University of Belgrade, Faculty of Mechanical Engineering 2013.
2. Numerical examples with the solutions and the necessary data for the calculations are given in the framework of the books referred to in the point 1.
3. Power-Point presentations, lectures available to students in the form of hand-out materials.
4. Computer room with CATIA software (simulation and modeling of gear unit operation).
5. Design solutions of gear drive units.
6. Laboratory for Machine elements and Gear transmitters units.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 14
seminar works: 0
project design: 10
consultations: 0
discussion and workshop: 6
research: 0

**knowledge checks**

check and assessment of calculation tasks: 2
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 3
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 20
seminar works: 0
project design: 20
final exam: 30
requirements to take the exam (number of points): 35

**references**

Leitch R.D.: Reliability Analysis for Engineers, - Oxford scientific publications
Information Technology Projects Evaluation

**ID:** MSc-0512  
**responsible/holder professor:** Dondur J. Nikola  
**teaching professor/s:** Dondur J. Nikola  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** information technologies  
**semester.position:** 3.5

**goals**

Understanding of the importance of the planning process, assessment and evaluation of projects in the field of information technologies. Getting to know different methodological approaches for analysis of IT/IS projects. Learning the sophisticated techniques of financial and economic analysis, as well as standard techniques for management of IT/IS projects. Learning the techniques and routines for identification and monetary quantification of hardly visible costs and effects implied in the implementation of IT/IS projects.

**learning outcomes**

After having attended the module, the student should be able to: identify the project idea, prepare a database with all costs and effects of IT/IS projects, calculate criteria for selection of project alternatives, acquire knowledge and practices for recognition of hardly visible costs and effects of IT/IS projects, organise networks of activities, flows of project resources with choice of optimal paths and minimum costs and assess uncertainty and risk of IT/IS projects.

**theoretical teaching**

Projects in the area of information technologies, planning and assessment of IT/IS projects, methods of assessment and evaluation of IT/IS projects, standard (classical) methods of commercial assessment of IT projects, standard methods of economic assessment of IT projects, possible application of standard methods on IT/IS projects - COMFAR, COSTTAB, quantification of financial and economic net effects of IT/IS projects, analysis of uncertainty and risks in planning – use of software packages RISK, RISKVIEW, BESTFIT, CRYSTAL BALL, assessment and evaluation of IT/IS projects, management of IT/IS projects – use of software packages MSPROJECT, PRIMAVERA

**practical teaching**

Practical teaching consists of auditory and laboratory exercises as integral part of the module content. Auditory exercises include simple demonstrations of theoretical materials presented through examples and accompanied by the explanations to each step in the procedure of IT/IS project evaluation. In laboratory exercises, by using appropriate software packages, real examples of assessment, evaluation and management of IT/IS projects are prepared.

**prerequisite**

Required: Basic knowledge of computer science, economics and statistics. Preferred: attended modules on Databases, WEB Design.
learning resources

Softwares: EXCEL, MSPROJECT, RISKPROJECT, RISKFOREXCEL. Books: Economic Project Analysis, Information Technology Evaluation Methods and Management,

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 9
laboratory exercises: 15
calculation tasks: 0
seminar works: 16
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 1
check and assessment of lab reports: 1
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 4
test, with assessment: 4
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 55
laboratory exercises: 5
calculation tasks: 5
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references

Intelligent Buildings

ID: MSc-0656
responsible/holder professor: Ristanović R. Milan
teaching professor/s: Ristanović R. Milan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: control engineering
semester.position: 3.5

goals

To introduce students to the concept of intelligent buildings, technical systems in modern buildings and control systems technology and their integration.

learning outcomes

The acquired knowledge is used in engineering practice. The student is competent to understand the technical sub-systems in modern buildings, their configuration and mutual integration of electrical and mechanical systems and management concepts. Student is able to create ETS project and program KNX components. Student is able to make application schematics of HVAC system, to define signal list and define quote of sensors, actuators and controllers.

theoretical teaching


practical teaching

Understanding the physical implementation of sensors, digital controllers and drivers. Understanding the physical implementation of control systems in buildings. Programming and networking of digital controllers. Realization of simple solutions.

prerequisite

Basic automatic control knowledge and digital systems.

learning resources
M. Ristanovic, Intellingeng Buildings, printed lectures
Laboratory
KNX/EIB Trainings Kit
ETS3 - licensed software

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 45

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 5
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 50
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 10
final exam: 30
requirements to take the exam (number of points): 50

**references**
Тодоровић, Ристановић М, Ефикасно коришћење енергије у зградама, Универзитет у
H. Merz, T. Hansemann, C. Huebner, Building Automation, Springer-Verlag, Berlin
Heidelberg, 2009
C.F. Mueller, Regelungs- und Steuerungstechnik in der Versorgungstechnik, 2002
Intelligent Control Systems

ID: MSc-0657
responsible/holder professor: Jovanović Ž. Radiša

teaching professor/s: Jovanović Ž. Radiša

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: written

parent department: control engineering

semester.position: 3.5

goals

• Introduction to methods for the analysis and design of intelligent control systems.
• Gaining practical knowledge of several of the main techniques of intelligent control and an introduction to some promising research directions.
• Use of the computer for simulation and evaluation intelligent control systems.

learning outcomes

The course involve:
• understanding of the functional operation of a variety of intelligent control techniques
• the study of control-theoretic foundations,
• acquiring of the knowledge of intelligent systems design (control, production, etc.) based on combinations of various theories: simulation, neural networks, fuzzy systems, genetic algorithms, biologically inspired algorithms, etc.
• use of the computer for simulation and evaluation intelligent control systems through Matlab software, as and practical realization of control algorithms on various control plants using programming software Matlab and LabView.

theoretical teaching


practical teaching

PA:
Practical work includes computational exercises that follow the content of course.

PL:
Practice and experiments: computer applications in simulation and evaluation of intelligent control systems, as well as their practical realization using Matlab and LabView for control different plants within a modular educational real-time control system (double inverted pendulum, ball and beam system, DC servo motor).
prerequisite

Defined by curriculum of the study programme.

learning resources

• Radiša Jovanović, Intelligent Control Systems, Lecture notes in electronic form
• Radiša Jovanović, Matlab and Simulink in Automatic Control, Faculty of Mechanical Engineering, Belgrade, 2016.
• Modular educational real time control system with various control plants (DC servo motor, inverted pendulum, double inverted pendulum, heat flow experiment, coupled water tanks experiment), with acquisition hardware and software,
• PC and PC Embedded controllers, Siemens Simatic PLC, National Instruments controllers,
• Installation for control system testing and acquisition of electrical variables,
• Automatic Control Laboratory, Intelligent Control Systems Laboratory, Control Systems Laboratory.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 15
laboratory exercises: 10
calculation tasks: 0
seminar works: 5
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 6
check and assessment of projects: 0
colloquium, with assessment: 4
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 40
laboratory exercises: 5
calculation tasks: 0
seminar works: 0  
project design: 0  
final exam: 50  
requirements to take the exam (number of points): 25

references

Radiša Jovanović, Introduction to Neural Networks and Fuzzy Systems, Lecture notes, Faculty of Mechanical Engineering  
International Maritime Regulations

ID: MSc-0494

responsible/holder professor: Bačkalov A. Igor
teaching professor/s: Bačkalov A. Igor

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: written

parent department: naval systems

semester.position: 3.5

goals

To cover the basic aspects of International Maritime Regulations, their evolution and development, and (especially) their influence on ship design. Critical analysis of the present regulations.

learning outcomes

Understanding of the basic concepts of maritime regulations, their development and their influence on ship safety, environment, and ship design.

theoretical teaching

Rules, regulations and conventions in design, construction and operation of ships. Types of regulations: prescriptive regulations, probabilistic regulations, goal-based standards.


practical teaching

Practical examples and applications of the regulations covered by theoretical syllabus. Some detail of the regulations. Analysis of the impact of regulations on ship safety, environment, and ship design. The course is parallel to Ship Design, and the students implement the learned regulations to their individual projects.

prerequisite


learning resources

[1] Bačkalov, I., Extracts from lectures (handouts). /In Serbian/

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 10
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 50
requirements to take the exam (number of points): 34

**references**

Kuo, Ch., Safety Management and Its Maritime Application, The Nautical Institute, 2007
Man - machine system design

ID: MSc-0520
responsible/holder professor: Žunjić G. Aleksandar
teaching professor/s: Žunjić G. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: oral
parent department: industrial engineering
semester.position: 3.5

goals

The aim of this course is the acquisition of basic academic knowledge in the field of man - machine system design, which can be used for designing of different products and industrial systems, as well as for redesigning and improvement of system man - machine - environment. Students should acquire specific practical skills that include an integrated ergonomic approach for the purpose of a comprehensive settlement of various designing problems.

learning outcomes

Upon successful completion of this course, students should be able to:

- Identify the main types of mechanical hazards
- Carry out the selection and to apply the basic types of safety protections on machines
- Perform the identification of all other types of hazards in the working environment and to implement hazard analysis in a man - machine system
- Apply basic procedures for hazard prevention
- To realize the complete program for realization of safe products within the organization
- Identify different types of errors in the man - machine system and to apply appropriate solutions aimed at eliminating errors
- Conduct an ergonomic evaluation of design solutions of manuals
- Design technical and project documentation in accordance with the ergonomic recommendations

theoretical teaching


practical teaching


prerequisite

The necessary condition for attending the course is that the student have enrolled to the appropriate semester.
learning resources

Žunjić A., 2016, Script for man - machine system design, Faculty of Mechanical Engineering, Belgrade.

number of hours

total number of hours: 45

active teaching (theoretical)

lectures: 18

active teaching (practical)

auditory exercises: 2
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 16
consultations: 3
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 2
colloquium, with assessment: 0
test, with assessment: 0
final exam: 4

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 50
final exam: 40
requirements to take the exam (number of points): 40

references
Žunjić A., 2016, Script for man - machine system design, Faculty of Mechanical Engineering, Belgrade.
Microfluidics and Nanofluidics

**ID:** MSc-0940

**responsible/holder professor:** Stevanović D. Nevena

**teaching professor/s:** Milićev S. Snežana, Stevanović D. Nevena

**level of studies:** M.Sc. (graduate) academic studies

**ECTS credits:** 6

**final exam:** written+oral

**parent department:** fluid mechanics

**semester.position:** 3.5

**goals**

The aim of this subject is getting academic knowledge about fluid dynamical processes in micro and nano flows and introducing with scientific methods for predicting, analyzing and studying gas and liquid flow in structures of micrometer and nanometer characteristic dimensions.

**learning outcomes**

Students are trained to:
- apply the basic equations of fluid mechanics ie. equations of continuity, momentum and energy to describe the compressible and incompressible fluid flow in micro and nano channels;
- determine the velocity and pressure field for isothermal compressible and incompressible fluid flow in micro and nano channels, pipes and bearings for continuuma boundary conditions;
- calculate the velocity and pressure field for isothermal compressible gas flow in micro channels, pipes and bearings for the slip flow regime;
- calculate the velocity, pressure and temperature field for non-isothermal compressible gas flow in micro channels, for the slip flow regime;
- calculate the pressure and velocity field for electroosmotic flow in micro and nano channels and pipes;
- apply the law of diffusion equation and obtained analytical solutions which enables determination the change of a substance concentration in the micro channel with no fluid stream, as well as in the fluid stream;
- determine the equilibrium height in the capillaries and the time required for its achievement, as well as the change in the liquids position with time in the capillary pump.

**theoretical teaching**

Theoretical lessons contains fundamental fluid mechanics equations applied on fluid flow modeling in the micro and nano structures, rarefaction effect, slip and temperature jump boundary conditions, the behavior, manipulation and control of fluids that are confined to structures of nano and micrometer characteristic dimensions, electric double layer and Debye length, electrokinetic effects such as electrophoresis and electroosmosis which are often present in the micro-and nanofluidics, basic diffusion equations and some exact analytical solutions for the substance concentration in the fluid, the ability to use the process of diffusion for mixing and separation in micro and nanosystems, capillary phenomena that are important for micro and nanosystems, micro-pumps.

**practical teaching**
Practical lessons contain: application of the basic fluid mechanics equations, exact solutions for modeling fluid flow in the micro and nano structures which include different effects as rarefaction, slip and temperature jump at the wall, calculation of electro-osmotic flow for different channel geometries taking into account the presence of the double layer and Debye-Hückel approximation for the distribution of charge density in the electric double layer, calculation of electro-osmotic pumps of various structures, calculation of the propagation of the substance due to diffusion and advection for different conditions, calculation of capillary motion of fluids and capillary pump.

**Prerequisite**

Third semester of Master study

**Learning resources**


**Number of hours**

Total number of hours: 75

**Active teaching (theoretical)**

Lectures: 30

**Active teaching (practical)**

Auditory exercises: 0
Laboratory exercises: 0
Calculation tasks: 20
Seminar works: 5
Project design: 0
Consultations: 5
Discussion and workshop: 0
Research: 0

**Knowledge checks**

Check and assessment of calculation tasks: 5
Check and assessment of lab reports: 0
Check and assessment of seminar works: 5
Check and assessment of projects: 0
Colloquium, with assessment: 0
Test, with assessment: 0
Final exam: 5
assessment of knowledge (maximum number of points - 100)

feedback during course study: 10

test/colloquium: 0

laboratory exercises: 0

calculation tasks: 40

seminar works: 20

project design: 0

final exam: 30

requirements to take the exam (number of points): 30

references


Pumps and fans

ID: MSc-0446
responsible/holder professor: Nedeljković S. Miloš

teaching professor/s: Nedeljković S. Miloš, Čantrak S. Đorđe

level of studies: M.Sc. (graduate) academic studies

ECTS credits: 6

final exam: written

parent department: hydropower engineering

semester.position: 3.5

goals

Mastering knowledge of engineering applications of pumps and fans as machines for raising of fluid energy. Capacity to work in practice on energy installations, as well as design of installations that include a pump or blower as a built-in element with its function.

learning outcomes

After finishing this course, the students should be able to:
1. Know and recognize the types and designs of pumps and fans,
2. Calculate the pump/fan/system energy parameters and energy balancing,
3. Calculate and apply the dimensionless parameters - characteristic performance factors,
4. Determine the pump/fan/system working point,
5. Apply the energy characteristics of pumps/fans for establishment of operating regimes, as well as in their regulation.
6. Calculate the pump and the system cavitation characteristics,
7. Calculate the change of fan operating characteristics when working with density other than air.

theoretical teaching


practical teaching

various plants. Piston pumps - principles of work. Demonstrative laboratory exercises:
Institute (laboratory) for hydraulic machinery - showing PF constructions and description of
the role of individual parts. PF installations and description of their work.

**prerequisite**

The Fluid Mechanics B exam obligatory passed. Desirable that the student has passed the
examination of the subject Introduction to Energy Engineering.

**learning resources**

Faculty of Mechanical Engineering University of Belgrade, Belgrade 2010.
Handouts for the exercises.
Laboratory for hydraulic machines - equipment, installations, measuring equipment.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 26
laboratory exercises: 2
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 10
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 70
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 21

references
Selected topics in IC Engines 2

ID: MSc-1027

**responsible/holder professor:** Miljić L. Nenad

**teaching professor/s:** Knežević M. Dragan, Miljić L. Nenad, Popović J. Slobodan

**level of studies:** M.Sc. (graduate) academic studies

**ECTS credits:** 6

**final exam:** project design

**parent department:** internal combustion engines

**semester.position:** 3.5

**goals**

Acquiring new knowledge in the area of thermal piston machinery through analysis of the working cycle and particularities of piston compressors with reciprocating and rotational pistons. Broadening theoretical knowledge and analytical approach in the field of mathematical modelling and engine simulations through: model based fault diagnosis on various engine subsystems; Mean value models used in real-time engine control; Broadening knowledge in the area of automated engine mapping and calibration trough acquaintance with the state-of-the-art tools and techniques.

**learning outcomes**

Built skills for proper selection, calculation and design of piston compressor units. Practical experience gathered through realization of model-based diagnosis system on IC Engine. Understanding of crucial Mean-value models used in Engine control; Practical experience in building and testing a small scale engine subsystem control application; Understanding and acquaintance with the state-of-the-art mapping and modeling tools, principles and procedures.

**theoretical teaching**

1. Particularities of the piston mechanism, kinematics and dynamics of piston compressor’s piston mechanism; Crankcase force balancing in the multi cylinder / multi stage piston compressors; Compression of real gases, its mixtures and moist mixtures on high pressures; Real thermodynamic cycle of a piston compressor; Multi stage compression; Design and calculation of piston compressor parts; Auxiliaries and flow and pressure control systems; Maintenance issues.
2. Model based principles of technical system fault diagnosis; Model base fault diagnosis of engine subsystems (faults on engine’s air path, mixture formation, cylinder processes inequalities, cylinder misfire,...)
3. Engine control algorithms; Mean-value models and their application in engine real time control

**practical teaching**

1. Building a code for piston compressor real working process simulation. A project task with a goal for proper determination of the piston compressor unit design concept, its design calculation.
2. Practical experience of building model based fault diagnosis system (detection of air path
leaks or obstructions; detection of cylinder processes inequalities on a multi cylinder engine; misfire detection; model based real-time combustion parameter estimation)
3. Building an engine subsystem control system based on the application of common mean-value models (idle control, ignition system control, mixture formation system control,...)
4. Experience and practical work with the Inca calibration system (ETAS) on a engine test bed.
5. Experience and practical work with the tool for an automated engine mapping and calibration - Cameo (AVL)

prerequisite

Passed exam on course: "IC Engines Processes" and "Engine Mechatronics"

learning resources

Mathworks Matlab/Simulink IDE (Licenced)
AVL Advanced Simulation Tools (AST): Boost, Fire, Excite, Cruise
LMS AMESim
AVL Cameo; AVL Concerto;
Laboratories equipped with IC Engine testing equipement (fully equiped IC Engine test benches)
Laboratory instalation with a reciprocating piston and Roots type compressor.
DAQ Measurement equipement (National Instruments PXI based system with Labview Development software)

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 18
consultations: 2
discussion and workshop: 0
research: 10

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 10
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5
assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 70
final exam: 30
requirements to take the exam (number of points): 30

references

R. Jankov: Piston Compressors, Faculty of Mechanical Engineering, Belgrade, 5th edition, 1990, (on Serbian)
Paulweber, M., Lebert, K.: Mess- und Prüfstandstechnik: Antriebsstrangentwicklung · Hybridisierung ...
Tribological systems

ID: MSc-0537
responsible(holder) professor: Vencl A. Aleksandar
teaching professor/s: Vencl A. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: oral
parent department: engineering materials and welding, tribology, fuels and combustion
semester.position: 3.5

goals

The student attending this course should:
• Comprehend the issue and the importance of tribological processes in the most important machine elements (slide bearings, roller bearing, gear pairs, guides, seals, etc.);
• Master the calculation methods for tribological elements using the modern lubrication theories;
• Make decisions on selection of the type of lubrication and lubricants for lubrication of the major mechanical elements.

learning outcomes

Based on the mastered knowledge the student is qualified to:
• Recognize the basic parameters that impact the tribological properties of some system, as well as to explain their impact;
• Exterminates the basic mechanical systems from the tribological point of view by analyzing the structure of tribological systems;
• Propose the solutions for problems originate from the friction and wear process;
• Recognize the dominant type of wear in plain and roller bearings, gears, cam mechanisms, elements with linear reciprocating motion and dynamic seals;
• Applies methods for the calculation of working and tribological characteristics of considered tribological system;
• Select materials, lubricants and lubrication mode for the considered tribological systems.

theoretical teaching

• Definition of the tribological systems; Tribological characteristics of the mechanical systems.
• Bearings – purpose and types; Preliminary selection of bearing types; Reynolds equation.
• Sliding bearings (hydrodynamic, hydrostatic, sintered and self-lubricated); Calculation of: friction, minimum lubricant film thickness, lubricant flow, bearing load and oil or surface temperature; Selection of lubricants and lubrication procedures.
• Roller bearings; Calculation of: friction, minimum lubricant film thickness and oil temperature; Selection of lubricants and lubrication procedures.
• Gear pairs tribology – the influence of lubrication on the reliability and efficiency; Calculation of: friction, minimum lubricant film thickness, oil temperature, etc.; Selection of lubricants and lubrication procedures.
• Cam mechanisms tribology – materials and tribological characteristics; Selection of lubricants and lubrication procedures.
• Elements with reciprocating linear motion (piston-piston ring-cylinder system, slide ways and guides) – materials and tribological characteristics; Selection of lubricants and lubrication procedures.
procedures.
• Dynamic seals – type, purpose and materials; Calculation of the tribological characteristics; Selection of lubricants and lubrication procedures.

practical teaching

• Lubricants – role, type, classification and basic properties; Rheology of lubricants; Forms and types of lubrication.
• Examples for sliding bearings (hydrodynamic, hydrostatic, sintered and self-lubricated) tribological characteristics calculation.
• Examples for rolling bearings tribological characteristics calculation.
• Examples for gear pairs and cam mechanisms tribological characteristics calculation.

prerequisite

No special requirements.

learning resources

1. --, Handouts for each lecture.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 17
consultations: 13
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 6
colloquium, with assessment: 0
test, with assessment: 4
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5  
test/colloquium: 40  
laboratory exercises: 0  
calculation tasks: 0  
seminar works: 0  
project design: 25  
final exam: 30  
requirements to take the exam (number of points): 35

**references**

**Turbocompressors**

**ID:** MSc-0336  
**responsible(holder professor):** Petrović V. Milan  
**teaching professor/s:** Petrović V. Milan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** thermal power engineering  
**semester.position:** 3.5

**goals**

1. The achievement of academic competence in the field of compressors and thermal power plant engineering.  
2. Mastery of theoretical knowledge about how to transform mechanical work into internal energy of fluid by learning of thermodynamic processes and equipment.  
3. The acquisition of practical skills for design and optimization of turbocompressors.  
4. Mastering the techniques of process modeling.

**learning outcomes**

On completion of this programme, it is expected that student will be able to:  
• perform design of a multistage axial compressor writing own program code,  
• select dimensionless parameters of compressor stages,  
• apply one-dimensional theory of the compressor stage, determine the main dimensions of the stage, calculate efficiency and the stage operating parameters,  
• apply the appropriate solutions of 3D flow and define 3D blade geometry of the compressor stage  
• select the type of aero profile, calculate the aerodynamic losses and deviation  
• define the meridian flow path of the entire machine  
• apply different control modes for the turbocompressor  
• analyse compressor behavior at off-design operating parameters.

**theoretical teaching**

2. The aerodynamic background of turbocompressors.  
5. Theory of the cascade aerodynamic coefficients.  
7. Design factors of turbocompressors. Dimensionless velocity triangles. Dependence of the compression ratio from the operating parameters.  
8. Dependence of efficiency of the normal stages of axial compressor from the cascade aerodynamic coefficients and from the stage operating parameters.  
9. 3D flow in axial compressors stages. Optimal design factors. Determination of main dimensions of axial compressors.  
10. The behavior of the compressors at variable loads. Regulation of turbocompressors.

**practical teaching**
Practical training is carried out through:

Auditory exercises:
- Instructions for project 1: Calculation of main dimensions of axial compressors.
- Instructions for project 2: Design of the compressors cascades.

Project development:
- Calculation of main dimensions of axial compressors.
- Calculation of compressors cascades.

Labs:
- Learning the principles of operation and designing of compressors in Laboratory of steam and gas turbines.

**prerequisite**
Passed exams in Thermodynamics and Fluid mechanics

**learning resources**

Petrovic, M. scripts and handouts for Gas turbines
Instructions for performing laboratory exercises
Software package for calculating of properties of air and combustion products

**number of hours**

Total number of hours: 75

**active teaching (theoretical)**

- Lectures: 30

**active teaching (practical)**

- Auditory exercises: 9
- Laboratory exercises: 4
- Calculation tasks: 0
- Seminar works: 0
- Project design: 17
- Consultations: 0
- Discussion and workshop: 0
- Research: 0

**knowledge checks**

- Check and assessment of calculation tasks: 0
- Check and assessment of lab reports: 1
- Check and assessment of seminar works: 0
- Check and assessment of projects: 7
- Colloquium, with assessment: 2
- Test, with assessment: 0
- Final exam: 5
assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 10
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 50
requirements to take the exam (number of points): 25

references

Stojanovic, Thermal Turbomachinery, Gradjevinska knjiga, Belgrade, 1967.
Modern Quality Approaches

**ID:** MSc-0524  
**responsible/holder professor:** Veljković A. Zorica  
**teaching professor/s:** Veljković A. Zorica  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 2  
**final exam:** written  
**parent department:** industrial engineering  
**semester.position:** 3.5

**goals**

Purpose of the course is to introduce students to concepts and importance of quality in enterprises. Basic principles, methods and approaches are introduced to students. Three main topics are Total Quality Management, SRPS ISO 9001 standards and Six Sigma.

**learning outcomes**

After successfully completed projects and course, students should be able to use basic managerial and statistical quality methods. Students are informed about modern and current trends in quality, methods and software for quality improvement, with a possibility of applications.

**theoretical teaching**

The course include following subjects: Definitions and role of quality in enterprises, from the aspects of organizations and production; Defining real needs for quality and customer view; Basic quality tools, basic management quality tools. Basic statistics tools in quality; Three major approaches TQM - Total Quality Management, Quality standards, especially SRPS ISO 9001, and System Six Sigma. TQM include Deming’s approach, product characteristics, benchmarking, QFD, kayzen, 5s, etc. Quality standards are introduced to students through their structure, documentation, requests, advantages and limitations. System Six Sigma approach is represented with basic methodology DMAIC and consequent methods such as TRIZ, methods from TQM, Taguchi methods, Statistical methods etc, for every phase of DMAIC. Concept of data driven decision making is elaborated.

**practical teaching**

Students are introduced to software for quality methods. Main goal for students is the project based on practical examples and literature.

**prerequisite**

Course in statistics such as Quantitative methods or Probability and Statistics

**learning resources**

All materials for successful following of the course - handouts and other materials are distributed to students before lectures in electronic form. Part of the literature for projects.
number of hours

total number of hours: 30

active teaching (theoretical)

lectures: 10

active teaching (practical)

auditory exercises: 2
laboratory exercises: 3
calculation tasks: 0
seminar works: 8
project design: 0
consultations: 2
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 4
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 1

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 60
project design: 0
final exam: 30
requirements to take the exam (number of points): 31

references

**Skill Praxis M - BMI**

**ID:** MSc-1213  
**Responsible/holder professor:** Matija R. Lidiija  
**Teaching professor/s:** Matija R. Lidiija  
**Level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 4  
**Final exam:** seminar works  
**Parent department:** control engineering  
**Semester.position:** 4.1

**Goals**

The goal of the course is introducing students with operation and maintenance of instruments, apparatus and devices in different areas of medicine, especially in clinics and health centers. Professional practice should enable students to easier and quicker master final exam.

**Learning outcomes**

With mastering the course program, students get familiar with:

1. organizational problems of clinics, especially informational processes, databases  
2. functioning and maintenance of instruments for measurements, apparatus, and devices for diagnostics and therapy  
3. processes of maintenance of instrumentation, apparatus, and devices.

**Theoretical teaching**

Introducing students with implementation of practice, procedures, rules, documents related to protection on work.  
Schedule of practice.

**Practical teaching**

Visits to ordinations, hospitals, and health centers.  
Getting familiar with realistic work conditions in our country, and establishment of communication system with doctors (adaptation on medical terminology).  
Apparatus and devices management for early diagnostics of cancer and melanoma, ophthalmic procedures for constitution of sight.  
Interpretation of obtained results from the aspect sensitivity and specificity of obtained results.  
Analysis of functioning of apparatus for ultrasound, ECG, EEG,...  
Recording and analysis of information pathways, making the data base in clinics, Introducing the medical instrumentation.

**Prerequisite**

Attending practice in the institution.

**Learning resources**

Biomedical lab 2 at the Faculty of Mechanical Engineering.
number of hours

total number of hours: 90

active teaching (theoretical)

lectures: 40

active teaching (practical)

auditory exercises: 0
laboratory exercises: 40
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 5
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 0
laboratory exercises: 60
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 35
requirements to take the exam (number of points): 40

references

Practicum for Biomedical Engineering (handout).
Practicum in anatomy and human physiology for engineers (handout).
Practicum in biomedical devices and appliances (handout).
Skill Praxis M - BRO

ID: MSc-1220
responsible/holder professor: Kalajdić D. Milan
teaching professor/s: Kalajdić D. Milan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: seminar works
parent department: naval systems
semester.position: 4.1

goals

The student gains practical experience in the occupational environment where he will pursue his future career. He identifies essential functions of the business system in the domain of design, development and manufacturing as well as the role and tasks of a naval architect within such business system.

learning outcomes

The student should gain practical experience in the way of organizing and functioning of the environment where he will apply the acquired expert knowledge, identify models of communication with his colleagues and business information flows, identify fundamental processes in design, manufacturing, maintenance within the context of his future competence, establish personal contacts and acquaintances he will make use of during his schooling, or when applying for job in the future.

theoretical teaching

-

practical teaching

Practical teaching involves work in organizations where various activities are performed that have to do with naval architecture. The student chooses thematic unit and manufacturing company or research institution after consulting the Professor. In general, the student is allowed to conduct skill praxis in: shipyards, design and consulting agencies, companies dealing with ship and machinery maintenance, or one of the laboratories at the Faculty of Mechanical Engineering. Skill praxis can be done abroad as well. The student is obliged to keep a diary of skill praxis, where he will describe jobs he is doing, record his conclusions and remarks. After he completes the skill praxis, the student makes a report and provides explanations to the Professor. The report is handed over in the form of a seminar work.

prerequisite

It is only recommended to students MODULE OF NAVAL ARCHITECTURE

learning resources

number of hours

total number of hours: 90
active teaching (theoretical)

lectures: 0

active teaching (practical)

auditory exercises: 0
laboratory exercises: 80
calculation tasks: 0
seminar works: 5
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 60
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 0
final exam: 30
requirements to take the exam (number of points): 10

references
Skill Praxis M - HEN

**ID:** MSc-1210  
**Responsible/Holder Professor:** Ilić B. Dejan  
**Teaching Professor/s:** Ilić B. Dejan  
**Level of Studies:** M.Sc. (graduate) academic studies  
**ECTS Credits:** 4  
**Final Exam:** seminar works  
**Parent Department:** hydropower engineering  
**Semester Position:** 4.1

**Goals**

The goal of professional practice is that students in addition to theoretical work within subjects at the faculty get to know and experience the jobs in factories, institutes, laboratories and similar commercial enterprises and thereby gain insight into the activities to be performed. During the practice, students must keep a diary in which they enter a description of the tasks performed, and write down their conclusions and observations. Following the practice, students must write a report that is to be discussed about with the subject teacher.

**Learning Outcomes**

On successful completion of this course, students should be able to:
1. Write a report with a completed skill praxis,
2. Describe the operation and organization of the appropriate energy system or facility,
3. Demonstrate acquired practical experience and skills, related to specific jobs in the appropriate energy systems or facilities,
4. Acquire and develop team skills in work environment (communication with colleagues, professional ethics, etc.).

**Theoretical Teaching**

The course content is practical work, which consists of spending working time in certain organizations that perform various activities in mechanical engineering. The choice of a theme as well as a business or research organization is made in consultation with the concerned teacher. Students may perform their practice in: design and energy consulting profession organizations, organizations that produce and maintain power equipment, organizations that build and maintain power plants, waterworks companies and laboratories of the Department of hydraulic machines and power systems.

**Practical Teaching**

In the design and consultancy organizations, students are introduced to the process of design and analysis of power plants, acquire practical knowledge of engineering graphics, use of modern computer programs for designing and analyzing equipment and facilities, implementation of measures for rational use of energy and environmental protection and others. In organizations that produce and maintain power equipment they are acquainted with the process of equipment production, technological lines of production, quality control, and others. Within the companies for the construction and maintenance of power plants they acquire knowledge about the organization of construction, layout of equipment and technological systems in plants, and others. In power plants they get to know the appropriate processes, technology systems, fixtures and equipment, methods, process analysis, measurement of process parameters, operating the plant, and others. In the laboratories of
the Department of hydraulic machines and power systems they can become familiar with the available equipment and measuring equipment.

prerequisite

- learning resources

[1] Instructions for writing reports from professional practice,
[2] Guidelines for handling the equipment and facilities in the laboratories of the Department,
[3] Installation for testing the energy and cavitation features of turbine models, small hydro-power plants and hydro-mechanical equipment, available in the laboratory of the Department,
[4] Pelton turbine test rig
[5] Facility for studying cavitation phenomenon in pumps and hydrofoils with the visualization possibility
[6] Installation for flow visualization, determining pump hydraulic characteristics, variety of pump control possibilities, determining duct hydraulic characteristics
[7] Installation for flow meter calibration by volume method, testing of pumps and hydro-mechanical equipment
[8] Installation for flow meter calibration by volume method (56 l/s)
[9] Test rig for defining energy characteristics of the axial fans and swirl flow in diffusers (swirl chamber)
[10] Test rig with booster fan for fan and fluid flow phenomena investigations
[11] Installation for calibrating pressure gauges
[12] Calibration tunnel for velocity and pressure probes
[13] Test rig for exploring swirl flow in straight ducts
[14] PIV system
[15] LDA system
[16] CNC

number of hours

total number of hours: 90

active teaching (theoretical)

lectures: 0

active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 80
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks
check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 10
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 0

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 70
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references
Skill Praxis M - IBS

**ID:** MSc-1199  
**responsible/holder professor:** Marković D. Dragan  
**teaching professor/s:** Simonović D. Vojislav  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 4  
**final exam:** written  
**parent department:** agricultural engineering  
**semester.position:** 4.1

**goals**

Practical experience and stay in the student environment in which the student will realize his professional career. Identifying the basic functions of the business system in the field of design, development and production, as well as the roles and tasks of mechanical engineering in such a business system.

**learning outcomes**

Students get practical experience on the organization and functioning of the environment in which they will apply their knowledge in their future professional career. Student identifies models of communication with colleagues and business information flows. The student recognizes the basic processes in the design, manufacture, maintenance, in the context of his future professional competence. Establish the personal contacts and poznastva that will be able to use at school or entering into future employment.

**theoretical teaching**

Selected topics through practical activities.

**practical teaching**

Practical work podrazumva work in organizations that perform various activities in connection with mechanical engineering. Selection of thematic areas and commercial or research organizations carried out in consultation with the concerned teacher. Generally a student can perform the practice in manufacturing organizations, project and consulting organizations, organizations engaged in mechanical equipment maintenance, and public utility companies and some of the laboratories at Faculty of Mechanical Engineering. The practice may also be made abroad. During practice, students must keep a diary in which to enter a description of the tasks performed, the conclusions and observations. Following the practice must make a report to defend the subject teacher. The report is submitted in the form of the paper.

**prerequisite**

Students of modul IBS

**learning resources**

Laboratory and IT equipment
number of hours

total number of hours: 90

active teaching (theoretical)

lectures: 0

active teaching (practical)

auditory exercises: 0
laboratory exercises: 80
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 0

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 30
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 70
requirements to take the exam (number of points): 0

references
Skill Praxis M - IIE

ID: MSc-1201
responsible/holder professor: Spasojević-Brkić K. Vesna
teaching professors: Misita Ž. Mirjana, Spasojević-Brkić K. Vesna
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: written
parent department: industrial engineering
semester.position: 4.1

goals

The aim of the course is improvement of the practical knowledge acquired on master studies courses through familiarizing students with the environment in which they will develop professional career and the recognition of the basic functions of the business system in the field of industrial engineering, as well as the role and tasks of mechanical / industrial engineers in such a business system.

learning outcomes

This course attendance enables the following:
- Student recognizes the organization and functioning of the environment in which they will apply the acquired knowledge in their future professional career, based on the information / data collected in the field.
- Student connects the knowledge acquired in other courses.
- Student identifies and critically examines models of organization and flow of business information.
- Student recognizes the basic processes in the design, production, maintenance, inventory management, quality and safety and health at work, in the context of his future professional competencies and critically analyze them.
- Student establishes the personal contacts and friendships that will be able to use during the study or when entering into future employment.

Upon completion of the course, students have practical knowledge and skills in the field of business organization and sustainable development of enterprises.

theoretical teaching

The theoretical knowledge acquired during studies at the Faculty of Mechanical Engineering is used.

practical teaching

Company visits and analysis based on real data collected in the fields:
Topic 1.: The history and the activity in which the practice is carried out.
Topic 2.: The layout of the company
Topic 3.: Organizational chart of the company
Topic 4.: Staffing structure
Theme 5.: Sales and procurement services
Topic 6.: Development sector (if any)
Topic 7.: Production planning sector
Theme 8.: The manufacturing sector - Capacities and production cycle
Topic 9.: Sector / Subsector of Quality Management
Topic 10.: Storage and transport
Topic 11: Maintenance management systems, using the methods of industrial engineering.
After completion of practical training, students must make a report that will defend to the responsible teacher.

prerequisite

Enrolled semester

learning resources

1. Bulat V., Organization of production, Faculty of Mechanical Engineering, Belgrade, 1999. (in Serbian)
5. Sources collected in the companies.

number of hours

total number of hours: 90

active teaching (theoretical)

lectures: 5

active teaching (practical)

auditory exercises: 0
laboratory exercises: 35
calculation tasks: 0
seminar works: 0
project design: 45
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 0
final exam: 0

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 50
final exam: 50
requirements to take the exam (number of points): 30

references

Jovanovic T., Milanovic D. D., V Spasojevic., Modern organization and management, Faculty of Mechanical Engineering, Belgrade, 1996. (in Serbian)
Bulat V., Organization of production, Faculty of Mechanical Engineering, Belgrade, 1999.(in Serbian)
Klarin M., Industrial Engineering, Volume 1, The organization and planning of production processes, Faculty of Mechanical Engineering, Belgrade, 1996. (in Serbian)
Sources collected in the companies.
Skill Praxis M - MEH

**ID:** MSc-1202  
**responsible/holder professor:** Mitrović S. Zoran  

**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 4  
**final exam:** oral  
**parent department:** mechanics  
**semester.position:** 4.1

**goals**

Practical experience and time spent in an environment where the student realizes his professional career. Identifying the basic functions of the business system in the field of design, development and production, as well as the roles and tasks of mechanical engineers in such a business system.

**learning outcomes**

Student takes practical experience on the organization and functioning of the environment in which student will apply this knowledge in their future professional career. Student recognizes patterns of communication with colleagues and business information flows. Student identifies the core processes in the design, manufacture, maintenance, in the context of his future professional competence. Personal contact and acquaintance are established, which can be used during training, or future employment.

**theoretical teaching**


definition

**practical teaching**

Practical work involves working in organizations which perform a variety of activities related to mechanical engineering. The choice of thematic units and commercial or research organizations is carried out in consultation with the course teacher. Generally, a student may perform in practice: production companies, design and consulting organizations, organizations involved in the maintenance of mechanical equipment, public utility companies and some of the labs at the Faculty of Mechanical Engineering. The practice can also be performed abroad. During practice, students must keep a journal to enter a description of the work performed, the conclusions and observations. After carrying out the practice student must make a report to explain in details mentioned activities to course professor. The report is to be submitted in the form of the paper.

**prerequisite**

No

**learning resources**

Faculty of Mechanical engineering — course catalog — M.Sc. (graduate) academic studies — 801
Resources available on the site of professional practice.

**number of hours**

total number of hours: 90

**active teaching (theoretical)**

lectures: 0

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 10
colloquium, with assessment: 0
test, with assessment: 0
final exam: 80

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 70
final exam: 30
requirements to take the exam (number of points): 35

**references**
Skill Praxis M - MIT

ID: MSc-1232
**responsible/holder professor:** Mitrović B. Ćaslav
**teaching professor/s:** Mitrović B. Ćaslav
**level of studies:** M.Sc. (graduate) academic studies
**ECTS credits:** 4
**final exam:** project design
**parent department:** information technologies
**semester.position:** 4.1

**goals**

To provide students with practical experience of staying in an environment in which the student will realize his future career. Identifying the basic functions information system in the field of design, development and production software, as well as roles and tasks of mechanical engineering of information technology in such business system.

**learning outcomes**

Training students to apply previously acquired theoretical and practical engineering and scientific knowledge of information technology to solve specific practical engineering problems in the selected companies or Institutions. Activities to introduce students to selected companies or institutions, way of doing business, management and the place and role of IT engineers in their organizational structures.

**theoretical teaching**

MIT provides students with practical training by working with reputable companies and scientific research institutions of Serbia in the IT sector. Practical form for each candidate separately, in agreement with the management companies or research institutions in which pursuing their profession, and in accordance with the development of new information technologies from which the student has previously acquired theoretical knowledge.

**practical teaching**

Practical work consists of student involvement in the process of the enterprise or research institutions, consulting and writing diary professional practice in which a student describes the activities and operations that is performed during the professional practice

**prerequisite**

Required: Basic IT knowledge. Prior knowledge acquired in previous modules MIT courses listened.

**learning resources**

Lectures for MIT courses modules that can be downloaded from the FTP server module MIT: ftp://mit.mas.bg.ac.rs
number of hours

total number of hours: 90

active teaching (theoretical)

lectures: 0

active teaching (practical)

auditory exercises: 0
laboratory exercises: 80
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 10

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 60
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Skill Praxis M - MOT

ID: MSc-1222
responsible/holder professor: Knežević M. Dragan
teaching professor/s: Knežević M. Dragan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: seminar works
parent department: internal combustion engines
semester.position: 4.1

goals

Acquiring practical knowledge of mechanical engineer's duties. Gaining knowledge about company's structure, management and quality system. Practical knowledge of manufacturing processes and corresponding machine tools. Broadening and acquiring new knowledges in the fields of IC engines research and testing.

learning outcomes

Understanding company's structure and connections between various company parts. To comprehend the importance of teamwork in everyday engineering practice. Gaining practical skills in the field of CAD/CAE/CAM/CAT.

theoretical teaching

Introduction. The role and importance of engineering practice in engineers education. Instructions on how to keep diary of practical training and how to write seminar paper. Recommendations on proper company selection for practical training. A two-stage practical training is expected: first stage in companies that design and build engines, engines parts and systems. Second stage will be in the Center of IC Engines, where students participates in design and completion of engine test beds, measuring systems and software production and testing, as well as participation in engine testing processes.

practical teaching

a) consultations during practical training; b) practical training b1. practical training in selected company (2/3 of practical training); b2. practical training in the Center of IC Engines (1/3 of practical training).

prerequisite

Passed exams: Engine Working Processes, Engine fuelling and ignition systems. Company's agreement to accept a student for practical training.

learning resources

Instructions for Engineering practice to carry out, (PDF file). Computers and licensed software in the Center of IC Engines. Test beds for engines and engine systems testing at the same center.

number of hours
total number of hours: 90

**active teaching (theoretical)**

lectures: 10

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 40
calculation tasks: 0
seminar works: 10
project design: 0
consultations: 10
discussion and workshop: 10
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 4
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 6

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 20
calculation tasks: 0
seminar works: 40
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**
Skill Praxis M - MOV

ID: MSc-1224
responsible/holder professor: Rakićević B. Branislav
teaching professor/s: Aleksendrić S. Dragan, Blagojević A. Ivan, Vasić M. Branko, Mitić R. Saša, Popović M. Vladimir, Rakićević B. Branislav
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: seminar works
parent department: motor vehicles
semester.position: 4.1

goals

Aim of praxis is to introduce procedures and processes in production of vehicles and their components to students, and also specific activities related to development and production, testing, exploitation and maintenance of vehicles and their systems.

learning outcomes

With this praxis, students in particular conditions (vehicle production, maintenance, testing and exploitation), achieve practical view on production of elements, components and vehicle systems, as well as on problems of vehicle completion, exploitation and maintenance, according to the plan and the program of practice.

theoretical teaching

No theoretical classes.

practical teaching

Students autonomously choose companies to complete the praxis in. Students' activities are performed according to guidelines and instructions on how to behave and on the subjects of interests during the stay in particular company, and also on how to write the praxis diary.

prerequisite

No special requirements.

learning resources

Instructions for writing the praxis diary.

number of hours

total number of hours: 90

active teaching (theoretical)

lectures: 0

active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 80
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 8
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 2

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 60
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

references

All available literature from courses from Motor Vehicle Department.
Skill Praxis M - PRM

ID: MSc-1176
responsible/holder professor: Šiniković B. Goran
teaching professor/s: Andrejević S. Raša, Veg A. Emil, Šiniković B. Goran
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: seminar works
parent department: theory of machanisms and machines
semester.position: 4.1

goals

1. Obtaining practical knowledge in the field of food processes and machines.
2. Getting knowledge about the machine materials necessary for use in the manufacture of food machines.
3. Development of students' creative abilities for designing food devices, machines and systems, by analysis of structures and exploitation characteristics of food machines and plants.

learning outcomes

By mastering the study program student acquires the ability:
- Analysis of existing solutions and their effects.
- Acquisition of practical knowledge.
- Application of acquired knowledge in practice.

theoretical teaching


practical teaching

First seminar paper and second seminar work. Introduction with the production process in the systems involved in the production of food products covered by lectures. Tour companies that design and construct plants, as well as the production of food processing equipment. Getting to know the work of companies that deal with the design and construction of the plant, as well as the production of equipment for the production of food products. Consultations: consideration of completed active teaching and students' questions

prerequisite

No additional conditions for attending the course Professional Practice M-PRM

learning resources

In order to successfully master the subject, it is necessary to use Internet resources, prospect material of producers and users of food equipment and videos.
number of hours

total number of hours: 90

active teaching (theoretical)

lectures: 25

active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 40
project design: 0
consultations: 15
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 6
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 4

assessment of knowledge (maximum number of points - 100)

feedback during course study: 20
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 50
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references
Skill Praxis M - PRO

ID: MSc-1195
responsible/holder professor: Slavković R. Nikola
teaching professor/s: Mladenović M. Goran, Slavković R. Nikola
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: seminar works
parent department: production engineering
semester.position: 4.1

goals

The student gains practical experience and gets familiarized with the future occupational environment. The student identifies basic functions of the business system in the domain of design, development and manufacturing as well as the role and tasks of the mechanical engineer within such a business system.

learning outcomes

Upon successful completion of this course students should be able to:
(1) Apply practical experience on the organization and functioning of the business environment in which they will apply the acquired knowledge in their future professional career.
(2) Students can identify the models of communication with the colleagues and business information flow.
(3) Solve basic processes in the design, manufacturing, maintenance within the context of their future competences.
(4) Establish of contacts and acquaintances are useful during graduate studies as well as for applying for the job in the future.
(5) Prepare by Report professional practice upon on the completed tasks in given topics.

theoretical teaching

This professional practice M PRO has no lectures. Students use the knowledge acquired during their studies at the Faculty of Mechanical Engineering.

practical teaching

Practical teaching means work in the companies where various activities related to mechanical engineering are proceeding. The subject matter and business company or research institution is selected in consultation with the professor. In principle, the student is allowed to conduct skill praxis in manufacturing companies, design and consulting firms, enterprises for machine equipment maintenance, public enterprises and municipal service companies or any laboratory at FME. Skill praxis can also be performed abroad. Students are obliged to keep a diary of skill praxis, where they describe the jobs they are doing, write down deductions and perceptions. Having completed the skill praxis the students must make a report they will defend in front of the professor. The report is handed over in the form of a seminar work.

prerequisite

Defined by the Study Program Curriculum.
learning resources

Laboratories of the Department of Production Engineering.

number of hours

total number of hours: 90

active teaching (theoretical)

lectures: 0

active teaching (practical)

auditory exercises: 0
laboratory exercises: 80
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 70
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 50

references
Skill Praxis M - PTH

ID: MSc-1208
responsible/holder professor: Petrović LJ. Aleksandar
teaching professor/s: Petrović LJ. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: written
parent department: process and environmental protection engineering
semester.position: 4.1

goals

The goal of course is to acquaint students with the resources, machines and devices used in various industries, especially in the food and pharmaceutical industry, chemical industry, oil refining, gas, non-metals and building materials, metallurgy, energy, communal activity. The practice should enable students to easily master the subject matter of vocational subjects.

learning outcomes

The successful completion of course students are introduced to: 1. processes and equipment used in the processing industry, 2. designing methods of processing plants, 3. test methods of processing plants and equipment, and others.

theoretical teaching

The role and importance of professional practice - process engineering, engineering in environmental protection. Basic principles of devices and machines of process equipment. Fundamentals of technological processes in the field of process engineering. The basics of designing process systems. The basics of distributions main and auxiliary fluids.

practical teaching

Organization and visits to factories of process industries. Understanding the specific technological processes and equipment in process industries through a review of technical documents and examining the situation in the factories. Analysis of technical documents (project and technical documentation) in the process industries. Technical control (audit) of technical documents - from compliance with documentation requirements of regulations and standards in the field of process industries. Introduce students to the measuring equipment used in the process industry by direct insight into condition of this equipment in factories and laboratories at its disposal department. The role of process engineers in the design and implementation of systems management processes and technologies.

prerequisite

Obligatory subject of elective module Process engineering and environment protection.

learning resources


number of hours
total number of hours: 90

**active teaching (theoretical)**

lectures: 10

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 70
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 10

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 30
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 25

**references**
Skill Praxis M - SAU

ID: MSc-1214  
**responsible/holder professor:** Ristanović R. Milan  
**teaching professor/s:** Ribar B. Zoran, Ristanović R. Milan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 4  
**final exam:** written  
**parent department:** control engineering  
**semester.position:** 4.1

**goals**

Practical experience and stay student in an environment where will realize his professional career. Identifying the basic functions of the business system in the field of product development, production and use as well as the role and tasks of mechanical engineers in such a business system.

**learning outcomes**

After completion of the Professional training - M - SAU, students should gain insight into the practical aspects of the innovative and creative work of engineers in the next.  
- In recognition of the basic functions of the business system in the field of TS development, production and use of TS as well as the role and tasks of engineers in such a business system.  
- The manner of organization and functioning of the environment in which it will apply the acquired knowledge in their future professional career or entrepreneurial work.  
- The models of communication and flows in the development and implementation of product and market realization.  
- In recognition of the basic processes in engineering design, manufacture and maintenance of TS.

**theoretical teaching**

Introduction, aim, content activity.

**practical teaching**

Practical work means work in organizations where they perform various activities in connection with mechanical engineering. The choice of thematic units and commercial and research organizations carried out in consultation with the subject teacher. In principle, the student can carry out the practice in manufacturing organizations, project and consulting organizations, organizations dealing with maintenance of mechanical equipment, public utility companies and one of the laboratories at the Faculty of Mechanical Engineering. The practice may also be made abroad. During the practice students have to keep a diary in which to enter a description of the tasks they perform, the conclusions and observations. After completed practice must make a report that will defend in front of the subject teacher. The report shall be submitted in the form of a seminar paper.

**prerequisite**

-  

**learning resources**
Organizations that includes life-cycle product development, production, use.
- Organizations engaged in product development.
- Industrial Companies whose business is making products in mechanical engineering.
- Industrial Companies whose business is based on the use of mechanical systems.
- The companies whose activity is distribution and maintenance of machines and components.

number of hours

total number of hours: 90

active teaching (theoretical)

lectures: 2

active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
consultations: 0
discussion and workshop: 0
research: 48

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 50
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 20
project design: 0
final exam: 30
requirements to take the exam (number of points): 0

references
**Skill Praxis M - SIN**

**ID:** MSc-1218  
**responsible/holder professor:** Elek M. Predrag  
**teaching professor/s:** Elek M. Predrag  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 4  
**final exam:** seminar works  
**parent department:** weapon systems  
**semester.position:** 4.1

**goals**

Practical experience and student’s stay in the environment in which he will realize his professional career. Identifying the basic functions of the business system in the field of design, development and production, as well as the roles and tasks of mechanical engineer in such a business system.

**learning outcomes**

Students get practical experience on the organization and functioning of the environment in which they will apply their knowledge in their future professional career. Student identifies models of communication with colleagues and business information flows. The student recognizes the basic processes in the design, manufacture, maintenance, in the context of his future professional competence. Personal contacts and acquaintances are established that student will be able to use during study or entering into future employment.

**theoretical teaching**

Teaching is practical.

**practical teaching**

Practical work involves working in organizations that perform various activities in connection with mechanical engineering. Selection of thematic areas and commercial or research organizations is carried out in consultation with the concerned professor. Generally a student can perform the practice in manufacturing organizations, project and consulting organizations, organizations engaged in mechanical equipment maintenance, public utility companies and some of the laboratories at Faculty of Mechanical Engineering. The practice may also be made abroad. During practice, students must keep a diary in which he will enter a description of the tasks performed, the conclusions and observations. Following the practice they must make a report to defend of the subject professor. The report is submitted in the form of the paper.

**prerequisite**

No.

**learning resources**

**number of hours**

Total number of hours: 90
active teaching (theoretical)

lectures: 0

active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 80
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 60
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

references
Skill Praxis M - TKL

ID: MSc-1197  
**responsible/holder professor:** Bošnjak M. Srđan  
**teaching professor/s:** Bošnjak M. Srđan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 4  
**final exam:** seminar works  
**parent department:** material handling, constructios and logistics  
**semester.position:** 4.1

**goals**

The goal of the course is to inform students about the resources, machines and devices in the field of material handling used in various industries, especially in industry, construction, mining, transport,tourism, energy, process engineering, service industries, etc.

**learning outcomes**

The successful completion of course students are introduced to: 1 Production processes in companies that produce or use the funds for material handling, 2 Intralogistics, 3 Processes, maintenance of equipment and machinery for machinery, and others.

**theoretical teaching**

Introduction in material handling. Basics of the measures for safety and health at work when using the equipment and resources to work in general, especially in material handling. The basic principles of machines and devices for machinery. Fundamentals of technological processes in industry to manufacture machinery and construction machinery in the area. Fundamentals of design of transport and logistics systems.

**practical teaching**

Practical teaching is realized throughout the visits of the big industrial facilities and companies where are used and produces machines and devices for material handling in order to comprehend the material flow within intralogistics, production and technological characteristics of the processes needed for the realization of the devices, assembly process, maintenance, structural characteristics of the cranes and hoists, role of the engineering machines in building sites, role of the conveying systems and bucket wheel excavators within the open pits, warehouse and distribution systems... Also, it is performed presentation of the realized projects (designs) from the department in 10 year period. It is shown used methods, basic phases in the design processes (starting from the sketch up to final solutions), along with technical solutions for reconstruction of some machines for material handling.

**prerequisite**

No conditions.

**learning resources**


820
number of hours

total number of hours: 90

active teaching (theoretical)

lectures: 10

active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 50
project design: 0
consultations: 10
discussion and workshop: 10
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 60
project design: 0
final exam: 30
requirements to take the exam (number of points): 10

references

Skill Praxis M - TTA

ID: MSc-1204
responsible/holder professor: Todorović N. Maja
teaching professor/s: Todorović N. Maja
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: written
parent department: thermal science engineering
semester.position: 4.1

goals
Practical experience and the student presence in the environment in which the student will realize his professional career.
Identifying the basic functions of the business system in the field of design, development and production, as well as the roles and tasks of mechanical engineer in such a business system.

learning outcomes
Students get practical experience on the organization and functioning of the environment in which they will apply their knowledge in their future professional career. Student identifies models of communication with colleagues and business information flows. The student recognizes the basic processes in the design, manufacture, maintenance, in the context of his future professional competence. Students are establishing the personal contacts and acquaintances that will be able to use during studies or entering into future employment.

theoretical teaching
No theoretical lectures

practical teaching
Practical work involves work in organizations that perform various activities in scope of mechanical engineering. Selection of thematic areas, commercial or research organizations is carried out in consultation with the concerned teacher. Generally, a student can perform the professional practice in manufacturing organizations, design and consulting organizations, organizations engaged in mechanical equipment maintenance, and public utility companies and some of the laboratories at Faculty of Mechanical Engineering. The practice may also be made abroad. During practice, students must keep a daybook in which enters a description of the performed tasks, the conclusions and observations. Following the practice, a report must be handed over and defended before the subject teacher. The report is submitted in the form of the daybook.

prerequisite
No condition

learning resources
Handouts and documents obtained by the expert from the organization where the practice is done.
number of hours

total number of hours: 90

active teaching (theoretical)

lectures: 0

active teaching (practical)

auditory exercises: 0
laboratory exercises: 80
calculation tasks: 0
seminar works: 9
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 1

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 40
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references
Skill Praxis M - VAZ

ID: MSc-1216
responsible/holder professor: Bengin Č. Aleksandar
teaching professor/s: Bengin Č. Aleksandar, Dinulović R. Mirko, Petrović B. Nebojša
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: oral
parent department: aerospace engineering
semester.position: 4.1

goals

Practical experience and stay in environment in which the student will realize his professional career. Identifying the basic functions of the business system in the field of design, development and production, as well as the roles and tasks of an mechanical engineer in such a business system.

learning outcomes

Student gets practical experience on the organization and functioning of the environment in which they will apply their knowledge in their future professional career. Student identifies models of communication with colleagues and business information flows. The student recognizes the basic processes in the design, manufacture, maintenance, within the context of his future professional competence. Establish the personal contacts that will be able to use in further education, or entering into future employment.

theoretical teaching

-

practical teaching

Practical work involves working in organizations that perform various activities related to mechanical engineering. Selection of thematic areas and commercial or research organizations carried out in consultation with the concerned teacher. Generally, a student can perform the practice in manufacturing organizations, project and consulting organizations, organizations concerned with maintaining mechanical equipment, and public utility companies and some of the laboratories at Faculty of Mechanical Engineering. The practice may also be made abroad. During practice, students must keep a diary in which to enter a description of the tasks performed, the conclusions and observations. Following the practice must make a report to defend the subject teacher. The report is submitted in the form of the paper.

prerequisite

There aren't any compulsory conditions for course attendance.

learning resources

Resources available at the place of professional practice.

number of hours
total number of hours: 90

**active teaching (theoretical)**

lectures: 0

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 80
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 10

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 70
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**
Skill Praxis M - ZEM

ID: MSc-1225
geresponsible/holder professor: Lučanin J. Vojkan
teaching professor/s: Lučanin J. Vojkan, Milković D. Dragan, Simić Ž. Goran, Tanasković D. Jovan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: project design
parent department: railway mechanical engineering
semester.position: 4.1

goals

Students practical experience and stay in the environment in which the student will realize his professional career. Identifying the basic functions of the business system in the field of development, designing, production, maintenance of railway vehicles, as well as the roles and tasks of mechanical engineer in such a business system.

learning outcomes

After successfully finishing of skill praxis students would be able to:
- define and discuss about design processes, production and maintenance of railway vehicles;
- implementation of acquired practical knowledge about way of organization and functioning of producers and maintenance workshop of railway vehicles in the future professional career;
- recognize models of communication with colleagues and flows of business information;
- evaluate of the importance of team approach in resolving of problems, improving of production processes and maintenance of railway vehicles.

theoretical teaching

Introduce students to practical training realization concept and prepare them for all units of prescribed curriculum and way of communication. Guidelines for diary keeping and report writing are given and students record are created.

practical teaching

Practical work involves work in organizations with various activities in relations with mechanical engineering. Selection of thematic areas, commercial or research organizations students carrier out in consultation with the relevant teacher. Generally a student can perform the practice in manufacturing organizations, project and consulting organizations, organizations for maintenance of railway vehicles and in some of the laboratories at Faculty of Mechanical Engineering. The practice may also be done abroad. During practice, students must keep a diary in which have to enter a description of the tasks performed, the conclusions and observations. Following the practice must make a report which have to present to the relevant teacher. The report is submitted in the form of the paper.

prerequisite

Nothing

learning resources
Guide for keeping a practice diary and writing final report.

**number of hours**

total number of hours: 90

**active teaching (theoretical)**

lectures: 0

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 80
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 10
colloquium, with assessment: 0
test, with assessment: 0
final exam: 0

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 70
final exam: 30
requirements to take the exam (number of points): 30

**references**
Skill Praxis M - ZZK

ID: MSc-1230
responsible/holder professor: Sedmak S. Aleksandar
teaching professor/s: Sedmak S. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: project design
parent department: engineering materials and welding, tribology, fuels and combustion
semester.position: 4.1

goals

Objectives of this course are that students, after completing theoretical training, are prepared for their maximum involvement in practical training. Objective is that students become competent in the field of welding and gain appropriate academic skills, and also develop specific creative and practical skills that are needed in professional practice.

learning outcomes

By attending this course, provided by the curriculum of the subject, the student will be able to solve particular problems from practice, and to examine the possible consequences that may occur in case of bad solutions. The student will also able to link their knowledge from various fields and apply them in practice.

theoretical teaching

Introducing students to problems in practice.

practical teaching

Professional practice performance in the selected individual firms. Writing a report after practice.

prerequisite

required: Mechanical materials 1 and 2

learning resources

[1] Written lessons from lectures (handouts)
[3] Excerpts from the standard

number of hours

total number of hours: 90

active teaching (theoretical)

lectures: 15

active teaching (practical)
auditory exercises: 0
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 20
discussion and workshop: 20
research: 5

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 5
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 0
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 60
final exam: 30
requirements to take the exam (number of points): 35

references

Written lessons from lectures (handouts)
Прокић Цветковић Р., Поповић О., Mechanical materials 1
Plavšić N., Šijački-Žeravčić V., Stamenić Z.: Tables of mechanical materials, profiles, sheets and wires, Faculty of Mechanical Engineering, Belgrade, 2004;
Excerpts from the standard
Skill Praxis M - DUM

ID: MSc-1228

**responsible/holder professor**: Miloš V. Marko

**teaching professor/s**: Miloš V. Marko

**level of studies**: M.Sc. (graduate) academic studies

**ECTS credits**: 4

**final exam**: seminar works

**parent department**: general machine design

**semester.position**: 4.1

**goals**

Practical experience and stay student in an environment where will realize his professional career. Identifying the basic functions of the business system in the field of product development, production and use as well as the role and tasks of mechanical engineers in such a business system.

**learning outcomes**

After completion of the Professional training - M - DUM, students should gain insight into the practical aspects of the innovative and creative work of engineers in the next.

- In recognition of the basic functions of the business system in the field of TS development, production and use of TS as well as the role and tasks of engineers in such a business system.

- The manner of organization and functioning of the environment in which it will apply the acquired knowledge in their future professional career or entrepreneurial work.

- The models of communication and flows in the development and implementation of product and market realization.

- In recognition of the basic processes in engineering design, manufacture and maintenance of TS.

**theoretical teaching**

Introduction, aim, content activity.

**practical teaching**

Practical work means work in organizations where they perform various activities in connection with mechanical engineering. The choice of thematic units and commercial and research organizations carried out in consultation with the subject teacher. In principle, the student can carry out the practice in manufacturing organizations, project and consulting organizations, organizations dealing with maintenance of mechanical equipment, public utility companies and one of the laboratories at the Faculty of Mechanical Engineering. The practice may also be made abroad. During the practice students have to keep a diary in which to enter a description of the tasks they perform, the conclusions and observations. After completed practice must make a report that will defend in front of the subject teacher. The report shall be submitted in the form of a seminar paper.

**prerequisite**

- 

**learning resources**
Organizations that includes life-cycle product development, production, use.
- Organizations engaged in product development.
- Industrial Companies whose business is making products in mechanical engineering.
- Industrial Companies whose business is based on the use of mechanical systems.
- The companies whose activity is distribution and maintenance of machines and components.

**number of hours**

total number of hours: 90

**active teaching (theoretical)**

lectures: 2

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
consultations: 0
discussion and workshop: 0
research: 48

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 50
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 20
project design: 0
final exam: 30
requirements to take the exam (number of points): 50

**references**
Skill Praxix M - TEN

ID: MSc-1206
responsible/holder professor: Petrović V. Milan
teaching professor/s: Petrović V. Milan, Stevanović D. Vladimir
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: oral
parent department: thermal power engineering
semester.position: 4.1

goals

The aim of this course is to introduce students to the process of design and analysis of thermal power plants, processes and systems, power equipment manufacturing process, methods of calculation and analysis of mechanical and thermal loads of energy equipment, technological lines of production, quality control, organization of construction methods, maintenance schedules and technological systems at power plants, transportation, power equipment, modern methods of calculation.

learning outcomes

The successful completion of course students are introduced to: the appropriate energy processes, major and minor technological systems, the spatial distribution of equipment, methods, process analysis, measurement of process parameters, facilities management systems, etc.

theoretical teaching


practical teaching

Organization of visits to factories and
- design and consulting organization in the field of energy,
- organizations that produce and maintain equipment,
- organizations that build and maintain power plants and power plants,
- power plants and other power plants,
where part of the practice are held in the Faculty of Mechanical Engineering in the laboratories of the Department for thermal power engineering. In the laboratories of the Department for thermal students become familiar with the available equipment and measuring devices. In an independent work, students completing the technical report process with practice.

prerequisite
There are no preconditions

**learning resources**

Petrovic, M.: Instruction for steam turbine projet, Belgrade, 2004
Petrovic, M.: Scripts and handouts for Steam turbines

**number of hours**

total number of hours: 90

**active teaching (theoretical)**

lectures: 0

**active teaching (practical)**

auditory exercises: 2
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 78
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 10

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 70
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 70

**references**
Stojanovic, Thermal Turbomachinery, Gradjevinska knjiga, Belgrade, 1967.
Vocational foreign language

**ID:** MSc-0805  
**responsible/holder professor:** Vesić-Pavlović S. Tijana  
**teaching professor/s:** Vesić-Pavlović S. Tijana  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 2  
**final exam:** oral  
**parent department:** industrial engineering  
**semester.position:** 4.2

**goals**

Mastering English terms in the field of mechanical engineering and gaining skills for using professional literature in English, which contributes to students' active professional development and lifelong learning.

**learning outcomes**

Upon the completion of this course, students will be able to:
- use advanced professional vocabulary in both written and oral English language,
- write an abstract in English,
- analyze a scientific paper in English in terms of characteristic constructions.

**theoretical teaching**

Thematic contents in different branches of mechanical engineering, focusing on characteristic constructions and vocabulary in professional oral and written language. Mastering the formulations used in scientific papers in different fields of mechanical engineering. The structure of a scientific paper in English.

**practical teaching**

Oral and written exercises, interpreting charts and schemes in English. The presentation of a chosen scientific paper in English, making summaries, writing biography and job application.

**prerequisite**

Defined by the curriculum of the study programme/module.

**learning resources**


**number of hours**

**total number of hours:** 30

**active teaching (theoretical)**

lectures: 15

**active teaching (practical)**
auditory exercises: 5
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 5
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 0
final exam: 0

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 50
final exam: 40
requirements to take the exam (number of points): 20

**references**

Aberration theory and image analysis

ID: MSc-1153
responsible/holder professor: Micković M. Dejan
teaching professor/s: Micković M. Dejan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

The goal of a course Aberration theory and image analysis is to present all necessary theoretical and practical knowledge that is required for successful design of complex optical systems. The theoretical knowledge is obtained by studying various types of aberrations, the spot diagram, the point spread function, the optical transfer function and the diffraction. Emphases in aberration study are given on studying how aberrations appear and what are possible ways of correction aberrations.
The practical knowledge is obtained through the analysis of various existing optical systems in the standard program for optical design.

learning outcomes

At the end of the course students will have practical knowledge of understanding and calculating aberrations and other image analysis techniques like the spot diagram, the point spread function, the optical transfer function.

theoretical teaching

1. Wavefront aberrations
2. Primary aberrations
3. Seidel aberrations
4. Chromatic aberrations
5. Calculation of aberrations
6. Spot diagram
7. Point spread function
8. Observation and measurement of aberrations
9. Fundamentals of radiometry and photometry
10. Diffraction
11. Resolution of optical systems
12. Optical transfer function
13. Aberrational tolerances
14. Tolerances of optical elements

practical teaching

1. Calculation and analysis of aberrations in various optical systems by standard program for lens design,
2. Calculation and analysis of spot diagrams in various optical systems by standard program for lens design,
3. Calculation and analysis of optical transfer functions in various optical systems by standard program for lens design,
4. Visit to Laboratory for quantum and nonlinear optics, Photonics Center, Institute of Physics, University of Belgrade and demonstration of various types of lasers (femtosecond laser system Coherent Mira 900 D, continuous pumping laser system Coherent Verdi V10),
5. Visit to Laboratory for holography, optical materials and photonic crystals, Photonics Center, Institute of Physics, University of Belgrade and demonstration of interferometric measurements in optics.

prerequisite

There is no obligatory prerequisite.

learning resources

4. Standard program for lens design
5. Laboratory for quantum and nonlinear optics and Laboratory for holography, optical materials and photonic crystals, Photonics Center, Institute of Physics, University of Belgrade.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 2
laboratory exercises: 4
calculation tasks: 18
seminar works: 6
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 2
check and assessment of projects: 0
colloquium, with assessment: 8
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Actuating Systems

**ID:** MSc-0751  
**responsible(holder professor):** Miloš V. Marko  
**teaching professor/s:** Miloš V. Marko  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** seminar works  
**parent department:** MFB  
**semester.position:** subject offered only in English, without strictly defined position

**goals**

Acquisition of general and basic knowledge of the actuating systems.  
To qualify students to understand the actuating systems, main components and principle of operation.  
Training for further study.

**learning outcomes**

The knowledge gained will be used in engineering practice for initial design and selection the basic elements of various types of the actuating systems.

**theoretical teaching**

An overview of the actuating systems including the general overview of the various type of actuators. Classification of the actuators according to the type of transformation & movement and according to the possible applications is presented. Electro-pneumatic (EPA), electro-hydraulic (EHA) and electro-mechanical actuators (EMA) are discussed. General recommendations for design and testing, calculations and choosing of the components are included also.

Main Topics:

1. Electro-mechanical actuators (EMA) & Mechanical parts of EMA  
2. Electric motors  
3. Motor controller  
4. Control requirements, control system & stability  
5. Electro-hydraulic actuators (EHA) – configuration, working medium, servo-valves  
6. EHA – power sources, hydraulic motor design  
7. EHA – mathematical modeling and synthesis of control system  
8. Electro-pneumatic actuators (EPA) – configuration, mathematical modeling  
9. Simulation technique for the actuators  
10. Testing & verification of the actuators  
11. Some procedures in design of the actuators and quality assurance

**practical teaching**

1. Visiting to Component Maintenance Department of “JAT Tehnika - aircraft maintenance center” in Belgrade.  
3. Visiting to Department of Automatic Control of Faculty of Mechanical Engineering.  
4. EMA presentation – office 136 [Faculty of Mechanical Engineering.]
prerequisite

None

learning resources

Moodle (Modular Object-Oriented Dynamic Learning Environment, a free, open-source PHP web application for producing modular internet-based courses that support a modern social constructionist pedagogy). Lectures, power point presentations, room equipped with computers & software for design and simulations, handouts.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 40

active teaching (practical)

auditory exercises: 0
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 15
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 0

assessment of knowledge (maximum number of points - 100)

feedback during course study: 15
test/colloquium: 0
laboratory exercises: 40
calculation tasks: 0
seminar works: 45
project design: 0
final exam: 0
requirements to take the exam (number of points): 0

references
M. Milos, Actuating Systems, professor's handouts

Advanced interior ballistics

ID: MSc-1234
responsible/holder professor: Micković M. Dejan
teaching professor/s: Micković M. Dejan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

Introducing students to the basics of classic projectile propulsion. Study of fundamental processes that occur during firing in the gun barrel. Influence of characteristics of propellants on firing processes. Setting up a system of equations describing these processes and methods for solving the system. Design of propellant systems. Study of methods of solving the basic task of interior ballistics and ballistic design. The study of characteristics of special types of weapons. Consideration of methodology of interior ballistic tests.

learning outcomes

Student gets knowledge of principles and basic equations of the propulsion. Student is trained for the calculation of basic parameters of interior ballistics. Student acquires fundamentals for subsequent detailed study of various types of propulsion. Mastering the calculation of direct and indirect task of interior ballistics of various types of weapons, and the methodology of interior ballistic tests.

theoretical teaching

Introduction to interior ballistics.
Gun propellants and their characteristics.
Basic processes and laws during firing process.
Solution of the basic task of interior ballistics (task statement, analytical method of solving, propellant gas temperature calculation, tabular method of solving).
Ballistic design.
The solution of the task of internal ballistics for the combined (howitzer) charge.
Interior ballistics of recoilless weapons.
Interior ballistics of mortars.
Corrective formulas of interior ballistics.

practical teaching

Combustion of gunpowder. Examples of calculations
4. The basic equations of propulsion systems. Problems
Production of gunpowder.
Tabular method of solving the basic task of interior ballistics.
Interior ballistic design (Task of gun tube design. Interior ballistic characteristic of weapons.
General dependence of structural tube characteristics on charge conditions. Directive diagram and its analysis.
The solution of the task of interior ballistics for the combined (howitzer) charge. Corrective formulas of interior ballistics. Selected examples.

**prerequisite**

No.

**learning resources**

2. Interior ballistic design tables.
3. Correctional coefficients tables.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 15
seminar works: 0
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 5
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 60
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Advanced missile guidance and control

**ID:** MSc-1155  
**responsible/holder professor:** Todić N. Ivana  
**teaching professor/s:** Todić N. Ivana  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** MFB  
**semester.position:** subject offered only in English, without strictly defined position

**goals**

Acquiring knowledge in the field of missile guidance and control with the possibility of applications in the fields of research and development, designing, manufacturing, marketing, operational use and analysis of modern guided missiles. Mastering the methodology of the calculations of dynamic characteristics of guided missiles (maneuverability, stability, the natural frequency, etc.), autopilot synthesis and synthesis of different types of guidance laws.

**learning outcomes**

The student acquires general knowledge in the areas of analysis and synthesis system of guided missiles that enables participation and communication in work teams involved in the development of guided missiles. With the use of modern software tools developed in MATLAB and Simulink, are qualified for the trajectory calculation of guided missiles, aerodynamic transfer function calculation and the synthesis of the autopilot and the missile guidance system. It has acquires knowledge in the areas of testing of missile guidance system.

**theoretical teaching**

Introduction to the theory of guidance and control of the missiles (the basic principles of guidance and control). Analysis of dynamic characteristics of missiles and calculation of aerodynamic transfer functions. Requirements and methods of designing autopilots. Analyses and syntheses of proportional navigation, command to LOS guidance and different approaches for trajectory correction and trajectory guidance.

**practical teaching**

The practical realization of guided missiles (analyzed various construction solutions of guided missiles to review the role of guidance and control subsystem. The application of MATLAB and Simulink in design). Designing pitch, yaw and roll autopilots. Each student should solve project of guidance system for the given missile data.

**prerequisite**

None.  
Passed exams (preferably): flight dynamics and aerodynamics of projectiles, Fundamentals of automatic control

**learning resources**

Cuk, D.: Lectures in course Missile guidance and control, Faculty of Mechanical Engineering, Belgrade, 2002 (handouts)
number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 25

active teaching (practical)

auditory exercises: 5
laboratory exercises: 5
calculation tasks: 10
seminar works: 0
project design: 15
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 25
final exam: 45
requirements to take the exam (number of points): 0

references

Advanced optical system design

**ID:** MSc-0840  
**responsible/holder professor:** Milinović P. Momčilo  
**teaching professor/s:** Milinović P. Momčilo  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** MFB  
**semester.position:** subject offered only in English, without strictly defined position

**goals**

The goal of the course Advanced optical system design is to transfer practical knowledge in designing various optical systems. This means that students will learn from very beginning how to design various optical systems. The complexity of optical systems varies from simple ones with only one or two lenses to quite complex ones with up to ten lenses.

Each lecture will cover the design of one kind of the visual optical systems. The first part of lecture will give theoretical introduction and the second part of lecture will consist of interactive design and analysis of selected optical system in standard optical design program.

**learning outcomes**

At the end of the course students will have practical knowledge of designing all basic visual optical systems. This means that students can design various optical systems from the Wollaston landscape lens to the Petzval and the Double Gauss lens. Students will have necessary knowledge for designing various double mirror objectives like the Newton system, the Cassegrain system and the Gregory system.

**theoretical teaching**

1. Design of the best form lens
2. Design of the Wollaston landscape lens
3. Design of the cemented doublet
4. Design of the French landscape lens
5. Design of the separated doublet
6. Design of the finite separated doublet
7. Design of the Cooke triplet
8. Design of the Tessar lens
9. Design of the Petzval lens
10. Design of the Telephoto lens
11. Design of the Double Gauss lens
12. Design of the Schmidt system
13. Design of the Bouwers – Maksutov system
14. Design of the Newton two mirror system
15. Design of the Cassegrain two mirror system
16. Design of the Gregory two mirror system

**practical teaching**

1. Analysis of the best form lens in standard lens design program
2. Analysis of the Wollaston landscape lens in standard lens design program
3. Analysis of the cemented doublet in standard lens design program
4. Analysis of the French landscape lens in standard lens design program
5. Analysis of the separated doublet in standard lens design program
6. Analysis of the finite separated doublet in standard lens design program
7. Analysis of the Cooke triplet in standard lens design program
8. Analysis of the Tessar lens in standard lens design program
9. Analysis of the Petzval lens in standard lens design program
10. Analysis of the Telephoto lens in standard lens design program
11. Analysis of the Double Gauss lens in standard lens design program
12. Analysis of the Schmidt system in standard lens design program
13. Analysis of the Bouwers–Maksutov system in standard lens design program
14. Analysis of the Newton two mirror system in standard lens design program
15. Analysis of the Cassegrain two mirror system in standard lens design program
16. Analysis of the Gregory two mirror system in standard lens design program

prerequisite

There is no obligatory prerequisites.
Passed exam prefered:
- Introduction to optical system design
- Aberration theory and image analysis

learning resources

4. Standard program for lens design

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 20
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 30
final exam: 30
requirements to take the exam (number of points): 35

references

4. Standard program for lens design
Airframe Structural Analysis

**ID:** MSc-0747  
**responsible/holder professor:** Grbović M. Aleksandar  
**teaching professor(s):** Grbović M. Aleksandar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** MFB  
**semester.position:** subject offered only in English, without strictly defined position

**goals**

The Airframe Structure Analysis course aims to provide a clear introduction to the fundamental theory of structural analysis as applied to vehicles, aircraft, spacecraft and ships. The emphasis is on the application of fundamental concepts of structural analysis in everyday engineering practice. Coverage of elasticity, energy methods and virtual work set the stage for discussions of airworthiness/airframe loads and stress analysis of aircraft components.

**learning outcomes**

This course will give students an appreciation of the criteria used for selecting aircraft materials and designing aircraft structures. Students will get an overview of how structural loading and stress analysis influence the decisions upon aircraft shape and airworthiness. It is intended for students who need to be aware of the influence of aircraft materials and structural considerations in the development of aircraft design.

**theoretical teaching**

1. Basic Elasticity  
2. Two-Dimensional Problems in Elasticity  
3. Virtual Work and Energy Methods  
4. Bending of Thin Plates  
5. Euler Buckling of Columns  
6. Buckling of Thin Plates  
7. Loads on Structural Components of Aircraft. Materials used in design.  
10. Bending of Open and Closed, Thin-Walled Beams.  
11. Shear of Beams.  
12. Torsion of Beams.  
13. Combined Open and Closed Section Beams.  
14. Wing Spars and Box Beams. Analysis.  
15. Bending, shear and torsion of fuselage.  
16. Bending, shear and torsion of wing.

**practical teaching**

During practical work students will learn different "manual" and computer based methods for solving typical aircraft structure analysis problems.

**prerequisite**
Fundamental background in higher mathematics is required. Students should have seen the following topics: derivatives, integration, matrices.

**learning resources**

Handouts, Virtual classroom (Moodle), Powerpoint presentations, Recommended literature and websites

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10  
laboratory exercises: 0  
calculation tasks: 5  
seminar works: 0  
project design: 5  
consultations: 10  
discussion and workshop: 0  
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0  
check and assessment of lab reports: 0  
check and assessment of seminar works: 0  
check and assessment of projects: 5  
colloquium, with assessment: 0  
test, with assessment: 5  
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 15  
test/colloquium: 15  
laboratory exercises: 0  
calculation tasks: 0  
seminar works: 20  
project design: 20  
final exam: 30  
requirements to take the exam (number of points): 30

**references**
A. Grbovic, Handouts, Faculty of Mechanical Engineering, Belgrade, 2010.
Analytic Methods for Engineering Design

ID: MSc-0753  
**responsible/holder professor:** Babić R. Bojan  
**teaching professor/s:** Babić R. Bojan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** seminar works  
**parent department:** MFB  
**semester.position:** subject offered only in English, without strictly defined position

**goals**

Course aim is to scrutinize the design process in its entirety, from problem definition to conceptualization to embodiment and realization, in a discipline-independent framework, with the purpose of gaining insight into the process from the most general viewpoint.

**learning outcomes**

Apply mathematical, scientific and programming methods to find appropriate solutions to engineering problems. Advanced application of axiomatic design theory for design of products, manufacturing processes and manufacturing systems. Ability for structuring and decomposing designs in order to systematically apply design axioms. Advanced application of design software. Teamwork abilities.

**theoretical teaching**


**practical teaching**


**prerequisite**

Defined by curriculum of study programme/module.

**learning resources**

(1) I-TRIZ Innovation WorkBench – a comprehensive software tool for inventive problem solving.
solving.
(2) I-TRIZ Ideation Brainstorming – a simplified tool for solving problems of light to medium complexity.
(3) Axiomatic design software

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 22
calculation tasks: 0
seminar works: 8
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 6
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 4
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 15
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 35
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**
B. Babic, FLEXY–INTELLIGENT EXPERT SYSTEM FOR FMS DESIGN, Intelligent Manufacturing Systems Series, Book 5, University of Belgrade, Faculty of Mechanical Engineering, 1994, 18.1
Applied optimization theory in optical system design

ID: MSc-0841

**responsible/holder professor:** Elek M. Predrag  
**teaching professor/s:** Elek M. Predrag  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** MFB  
**semester.position:** subject offered only in English, without strictly defined position

**goals**

The goal of a course Applied optimization theory in optical system design is to present necessary theory of the classical and the evolutionary optimization methods applied in the optical system design. Practical knowledge is obtained by applying several optimization methods in designing same optical system. This method enables to study good and weak points of various optimization methods and to choose the right optimization method for given optical system.

**learning outcomes**

At the end of the course students will have theoretical and practical knowledge of various classical and evolutionary optimization methods (dumped least squares, simulated annealing, genetic algorithms, evolutionary strategies) and their application in the optimization of optical systems.

**theoretical teaching**

1. Introduction to the optimization theory  
2. Least squares optimization  
3. Dumped least squares optimization  
4. Spence’s optimization  
5. Grey’s orthonormal optimization  
6. Simulated annealing  
7. Glatzel’s adaptive optimization  
8. Constrained optimization  
9. Simple genetic algorithm  
10. Adaptive steady state genetic algorithm  
11. Two membered evolution strategy ES EVOL  
12. Multimembered evolution strategy ES GRUP  
13. Multimembered evolution strategy ES REKO  
14. Multimembered evolution strategy ES KORR

**practical teaching**

1. Optimization of various optical systems by using damped least squares in standard program for lens design,  
2. Optimization of various optical systems by using adaptive steady state genetic algorithm in standard program for lens design,  
3. Optimization of various optical systems by using two membered evolution strategy ES EVOL in standard program for lens design,  
4. Optimization of various optical systems by using multimembered evolution strategy ES
GRUP in standard program for lens design,
5. Optimization of various optical systems by using multimembered evolution strategy ES
REKO in standard program for lens design,
6. Optimization of various optical systems by using multimembered evolution strategy ES
KORR in standard program for lens design.

prerequisite

There is no obligatory prerequisites.
Passed exam preferred:
- Introduction to optical system design
- Aberration theory and image analysis

learning resources

1. Vasiljević D.: Classical and Evolutionary algorithms in the optimization of optical systems,
3. Standard program for lens design.
4. Program for optimization of optical systems developed by Darko Vasiljevic.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 15
project design: 15
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 30
final exam: 30
requirements to take the exam (number of points): 35

references
Assembly Automation

**ID:** MSc-0977  
**responsible/holder professor:** Jakovljević B. Živana  
**teaching professor/s:** Jakovljević B. Živana  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** MFB  
**semester.position:** subject offered only in English, without strictly defined position

**goals**

Students acquire knowledge and develop practical skills referring to: the design and implementation of systems for automation of basic and auxiliary assembly processes, as well as automatic assembly systems as a whole; the design of products and processes for automatic assembly.

**learning outcomes**

Students obtain theoretical knowledge and practical skills in design of automatic assembly systems, in particular for automation of transfer, feeding, orienting, part mating, fastening and joining within fixed and flexible assembly automation; master scientific methods for analysis, synthesis and design of assembly process sequences for automatic assembly; acquire knowledge and practical skills in design of products (parts and assemblies) for automatic assembly.

**theoretical teaching**

1. Introduction to assembly;  
2. Structure of assembly system; basic, auxiliary and additional assembly processes;  
3. Assembly sequence analysis; liaison diagrams; Bourjault method; datum flow chain;  
4. Assembly transfer systems; continuous transfer; intermittent transfer; indexing mechanisms;  
5. Automation of feeding and orienting; vibratory feeders; design of orienting systems;  
6. Automation of fastening and joining processes;  
7. Mating of compliantly supported rigid parts; gross and fine motions; quasi-static force model;  
8. Vision systems in assembly automation; image analysis;  
9. Design for automatic assembly;  
10. Dimensioning and tolerancing for assembly; worst-case tolerancing; statistical tolerancing.

**practical teaching**

1. Auditory exercises: liaison sequence diagrams; quasi-static force model for mating of compliantly supported rigid parts; statistical and worst-case tolerancing  
2. Laboratory exercises:  
   - continuous and intermittent transfer systems  
   - experimental identification of forces during mating of compliantly supported rigid parts  
   - orienting of parts using vision system and image analysis  
3. Project: design of a system for automatic assembly of selected product
prerequisite

Defined by curriculum of study program

learning resources

1. Jakovljević Ž., Petrović P. B., Contact states recognition in robotized assembly, FME, Belgrade 2011 /In Serbian/
3. "Pick and Place" electro-pneumatic modular robots with programmable controllers, Lab for manufacturing automation
4. Lab desk with pneumatic, electro-pneumatic and electric components and programmable controllers, Lab for manufacturing automation
5. Programming computers, Lab for manufacturing automation
6. Communication network of computers and programmable controllers, Lab for manufacturing automation

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 8
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 12
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 2
colloquium, with assessment: 0
test, with assessment: 6
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 30
requirements to take the exam (number of points): 35

references

Automatic Control

ID: MSc-0566
responsible/holder professor: Ristanović R. Milan
teaching professor/s: Ristanović R. Milan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: control engineering
semester.position: subject offered only in English, without strictly defined position

goals

Acquisition of knowledge from the theory of linear control systems.

learning outcomes

Acquiring the knowledge obtained is used in engineering practice and the basis for monitoring the course of nonlinear systems and advanced courses of synthesis of linear systems.
Student is able to perform analysis and synthesis of PID control in linear systems.
Student is able to perform analysis of linear state space systems using the Matlab Simulink environment.
Student is able to perform analysis of linear systems in frequency domain using the Matlab Simulink environment.

theoretical teaching


practical teaching

The analysis using software tools MATLAB and Simulink. Experimental determination of the system transfer function. Experimental setup of the regulator.

prerequisite

Basic automatic control knowledge.

learning resources

• Literature on the website "Automatic control"
• Licensed Software in the possession of the Faculty.
• Freeware software.
• PCs.
• Laboratory of automatic control
• Rotary inverted pendulum
• Aero pendulum.
• NI cRIO.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 45

**active teaching (practical)**

auditory exercises: 5
laboratory exercises: 5
calculation tasks: 5
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 5
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5
test/colloquium: 45
laboratory exercises: 5
calculation tasks: 15
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 50

**references**
Combustion Physics

ID: MSc-1237
responsible/holder professor: Milivojević M. Aleksandar
teaching professor/s: Milivojević M. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

The aim of this subject is to provide students with the fundamental knowledge in combustion, the basic method of energy production, based on physical and chemical mechanisms of chemical reactions, transport phenomena, multiphase laminar and turbulent flows.

learning outcomes

After successful completion of this course, students should be able to:
- understand and improve combustion systems and environmental protection in practice.
- analyze modern combustion systems and environmental protection methods,
- validate combustion technologies in both existing and future energy transformation systems,
- apply the acquired knowledge in the areas of combustion science,
- work in research and development organizations.

theoretical teaching

1. Introduction. Elements of thermochemistry.
2. Chemical kinetics and equilibrium, Gibbs function.
3. Law of mass action, Arrhenius law, global and elementary reactions.
4. Transport phenomena.
6. Laminar non premixed flames.
7. Laminar premixed flames.
8. Combustion in turbulent flows; Detonation,
9. Two phase flows combustion.
11. Control of air pollutants.
12. Combustion in boundary layer flows; catalytic combustion; combustion in supersonic flows.

practical teaching

Practical tuition includes numerical analysis and examples of conservation of mass and energy laws regarding combustion and emissions. Experimental research includes non premixed and premixed flame characterization. Measurements of flue gas emission components will be performed in a purpose built test stand. A student will theoretically and numerically solve a problem in combustion.
prerequisite
Thermodynamics B exam passed

learning resources
The subject Handouts

number of hours
total number of hours: 75

active teaching (theoretical)
lectures: 30

active teaching (practical)
auditory exercises: 10
laboratory exercises: 5
calculation tasks: 5
seminar works: 5
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks
check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)
feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 10
seminar works: 20
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references
Computer Aided Design

**ID:** MSc-0733  
**responsible/holder professor:** Grbović M. Aleksandar  
**teaching professor/s:** Grbović M. Aleksandar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** MFB  
**semester.position:** subject offered only in English, without strictly defined position  

**goals**

The Computer Aided Design course aims to provide candidates with comprehensive 3D-CAD skills, as well as a detailed understanding of the main steps and design activities involved in the mechanical design process. The Computer Aided Design course will provide some 'in-depth' guidance for students who want to learn methods for creation of complex 3D parts and assemblies, as well as generation of accurate CAD drawings which should define students' design work. During the course, the students will be trained using CATIA v5 software, and will learn the following modules in detail: Part Design, Drafting and Assembly.

**learning outcomes**

Computer Aided Design is a course for students who wish to acquire a comprehensive advanced 3D-CAD skills and a recognised qualification that can provide the basis for professional development in a mechanical design related field. By completing this course, the students will be able to create simple and complex mechanical parts and assemblies within CATIA v5 environment, as well as precise drawings of designed parts/assemblies with all necessary dimensions and views. At the end of the course, the students will also be able to prepare their 3D models for further work (i.e. finite element analysis of parts and assemblies or tool design) and will have enough skills to understand advanced courses in CAD design (for example, surface design and sheet metal design).

**theoretical teaching**

Introduction to Part Design & Sketcher:  
Part Design Screen; Pull-down Menus; Toolbars in Part Design; Part Design Workbench; Sketcher Screen; Sketcher changes to bottom toolbar; Sketcher Workbench; Creating a new part with a new sketch

Creating basic shapes:  
Rectangle, Oriented Rectangle, Parallelogram, Elongated Slot, Elongated Curved Slot, Keyhole, Hexagon, Circle, Circle through 3 points, Circle with Cartesian coordinates, Circle tangent to 3 elements, Arc through 3 points, Arc through 3 points using limits, Arc, Spline, Connect Curve, Ellipse, Parabola, Hyperbola, Conic, Line, Unlimited Line, Bi-tangent Line, Bisect Line, Axis, Point, Point using coordinates, Equidistant points, Intersection Point, Projection Point.

Profile options:  
Constraints, Modifications of Sketch, Pad, Pocket, Shaft, Groove, Hole.
Creating and modifying parts:
Slot, Stiffener, Modifications to Shapes, Fillet, Chamfer, Draft Angle, Shell, Thickness, Modifying values, Interfacing with Sketcher, Patterns, Multisection Solid

Introduction to Drafting:
Views generation, Set the angle projection, Set the fillet generation, Additional views, Offset section view, Offset section cut, Detailed drafting.

Assembly Design Fundamentals:
Assembling Components, Positioning Components, Coincidence Icon, Contact Icon, Offset Icon, Fix Icon, Fix Together Icon, Analysing the assembly, Editing the assembly, Working with components, Creating the structure by inserting components, Positioning the components

CATIA Parameters and Formulas: Connecting CATIA with Excel; Design Table.

practical teaching

All topics previously mentioned in theoretical section will be practiced on computers with installed CATIA v5 software. Every icon (option) and methods of design will be demonstrated by lecturer and students will repeat the same steps in order to acquire skills necessary to pass the final exam.

prerequisite

No previous CAD experience or skills are required although it would be an advantage.

learning resources

Handouts, Virtual classroom (Moodle), Powerpoint presentations, Computers with CATIA v5 software, Educational movies, Recommended literature and websites

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 15

active teaching (practical)

auditory exercises: 5
laboratory exercises: 20
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 5
discussion and workshop: 5
research: 0

knowledge checks
check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 8
colloquium, with assessment: 3
test, with assessment: 0
final exam: 4

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 30
requirements to take the exam (number of points): 50

**references**

A. Grbovic: Handouts, Faculty of Mechanical Engineering, Belgrade 2010.
Control and Testing

ID: MSc-0772
responsible/holder professor: Ristanović R. Milan
teaching professor/s: Ristanović R. Milan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

Acquiring knowledge and deepening the theory of linear control systems. Training for the implementation and testing of the acquired knowledge to concrete physical systems and processes.

learning outcomes

The knowledge gained is used in engineering practice for analysis, synthesis and verification of dynamic properties of the system.

theoretical teaching


practical teaching

Analysis of the system through software tools MATLAB and Simulink. Experimental Determination of the system transfer function. Experimental setup controller.

prerequisite

Basic computer knowledge founded on PCs platforms. Basic knowledge of higher education mathematics. Basic knowledge of linear systems theory.

learning resources

• Literature on the website http://au.mas.bg.ac.rs/el - Moodle
• Licensed Software in the possession of the Faculty.
• Freeware software.
• PCs.
• Laboratory of automatic control

number of hours
total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10  
laboratory exercises: 10  
calculation tasks: 5  
seminar works: 0  
project design: 0  
consultations: 0  
discussion and workshop: 5  
research: 0

**knowledge checks**

check and assessment of calculation tasks: 3  
check and assessment of lab reports: 0  
check and assessment of seminar works: 0  
check and assessment of projects: 0  
colloquium, with assessment: 6  
test, with assessment: 2  
final exam: 4

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 5  
test/colloquium: 45  
laboratory exercises: 5  
calculation tasks: 15  
seminar works: 0  
project design: 0  
final exam: 30  
requirements to take the exam (number of points): 35

**references**

Digital image processing

ID: MSc-1154
responsible/holder professor: Elek M. Predrag
teaching professor/s: Elek M. Predrag
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

The course Digital Image Processing is practical course of the image analysis and processing. This means that students will learn from very beginning how to design various useful procedures and algorithms in: Photometry and Colorimetry, Image Sampling and Reconstruction, Discrete Image Mathematical Characterization, Superposition and Convolution, Geometrical Image Modification, Morphological Image Processing, Image Segmentation and Two-Dimensional Fourier Transform in image processing, Object Extraction and Detection, Texture and Pattern Matching and Detection of Geometric Elements.

learning outcomes

At the end of the course students will have gained practical knowledge necessary of understanding, design and use different types of algorithms in image analysis and processing.

theoretical teaching

1. Perception, photometry and colorimetry
2. Image sampling and noise
3. Cameras
4. Image algebra
5. Image enhancement techniques
6. Edge detection and boundary finding techniques
7. Thresholding techniques
8. Thinning and skeletonizing
9. Connected component algorithms
10. Morphological transforms and techniques
11. Linear image transforms
12. Pattern matching and shape detection
13. Image features and descriptors
14. Geometric image transformations

practical teaching

1. Development of algorithms for camera calibration
2. Development of algorithms for image enhancement techniques
3. Development of algorithms for object detection
4. Development of algorithms for linear image transforms
5. Development of algorithms for geometric image transformations
6. Development of algorithms for texture and pattern matching
prerequisite

There is no obligatory prerequisites.

learning resources

5. Standard programs for image processing (ImageJ, GIMP, ...)
6. Digital Image Processing (program for testing of algorithms) developed by Z. Nikolić.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 12
laboratory exercises: 0
calculation tasks: 12
seminar works: 6
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 2
check and assessment of projects: 0
colloquium, with assessment: 8
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Discrete Event Simulation

ID: MSc-0775
responsible/holder professor: Babić R. Bojan
teaching professor/s: Babić R. Bojan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

The aim of the course is to develop student's ability to model and analyze real system using discrete event simulation along with application of models, analysis of simulation results and comparison of alternative solutions.

learning outcomes

After the course the students will understand the power, characteristics and limitations of discrete event simulation and how it is applicable for analyses and development of manufacturing and other discrete systems. Students' abilities to implement the model in a computer system will be developed. Also students will be able to verify the model built, to evaluate and analyze the model output, to compare alternatives and to make appropriate suggestions for the real system.

theoretical teaching

Introduction to discrete event simulation. What is simulation, when it is applicable to use simulation, classification of models, types of simulation, steps in simulation study, advantages/disadvantages of simulation study. Concept of discrete event simulation, list processing. Simulation package AnyLogic. Application of simulation. Verification and evaluation of simulation models, analysis of output data, comparison of alternative designs of systems. Simulation of manufacturing systems.

practical teaching

General principles and simulation examples. Simulation of single-channel systems, event handling. Introduction to softwares for modelling and analysis of real systems based on discrete event simulation (lab work).

prerequisite

Defined by curriculum of study programme/module.

learning resources

(1) B. Babic, Handouts, University of Belgrade, Faculty of Mechanical Engineering, 2011, 18.1
(2) B. Babic, Electronic classrom for distance learning (http://147.91.26.15/moodle/), University of Belgrade, Faculty of Mechanical Engineering, 2011, 18.13
(3) AnyLogic simulation software

number of hours
total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 22
calculation tasks: 0
seminar works: 8
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 6
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 4
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 15
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 35
project design: 0
final exam: 30

requirements to take the exam (number of points): 30

references

Dynamics of Structures

ID: MSc-0757
responsible/holder professor: Grbović M. Aleksandar
teaching professor/s: Grbović M. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

The Dynamics of Structures course aims to provide candidates with a detailed understanding of methods of analysis of aircraft structures exposed to loads caused by flight maneuvers, gust or turbulence. Influences of structure elasticity on static and dynamic stability of the aircraft will also be considered.

learning outcomes

To provide a strong theoretical base for analysis and evaluation of aircraft structures subjected to dynamic loading.

theoretical teaching

1. Vibration of multiple degree of freedom systems
2. Time domain solution
3. Frequency domain solution
4. The homogeneous and the particular solution for forced vibrations with damping.
5. Generalized equations of motion – matrix approach
6. Whole aircraft ‘free-free’ modes
7. Effect of wing flexibility on lift distribution
8. Divergence and control effectiveness
9. Introduction to unsteady aerodynamics
10. Flutter
11. Fatigue of structures
14. Workshops and practical work.

practical teaching

During the practical work, students will learn how to solve typical dynamics of structure problems using both, modern numerical methods (FEM, BEM, XFEM) and classical (‘manual’) approach. Student will also conduct several laboratory experiments (fatigue testing of aircraft spar, vibration testing of fuselage bulkhead, etc.) and will learn how to produce lab reports in the form required by the industry.

prerequisite

Fundamental background in aircraft structure analysis is required. Students should have seen the following topics: matrices, vectors, linear algebra.
learning resources

Handouts, Virtual classroom (Moodle), Powerpoint presentations, Recommended literature and websites

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 20
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 5
discussion and workshop: 5
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 4
final exam: 4

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 20
calculation tasks: 40
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

references

A. Grbovic, Handouts, Faculty of Mechanical Engineering, Belgrade, 2011.
Dynamics of Smart Structures, Ranjan Vepa, John Wiley And Sons Ltd
Structural Dynamics: Theory and Applications, Addison-Wesley, Tedesco.
Fatigue of Thin Walled Structures

ID: MSc-0769
responsible/holder professor: Grbović M. Aleksandar
teaching professor/s: Grbović M. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

The main aims of Fatigue of Thin Walled Structures course are:
1. to emphasize the importance of fatigue failure problems in aircraft structures,
2. to indicate how this phenomenon can be analyzed and
3. how detailed analysis can contribute to the designing of fatigue resistant structures which will prevent structural fatigue problems in service.

learning outcomes

Knowledge of the fatigue mechanism in the material and how it can be affected by a large variety of practical conditions is the most important outcome of this course. Also, the students will gain basic knowledge about so-called "design against fatigue”. This approach includes not only the overall concept of the structure with related safety and economic aspects, but also questions on detail design, material surface quality, and joints used in aircraft structures. At the end of the course, the student should be skilled enough to try to predict (with good accuracy) the fatigue performance of aircraft structure, fatigue limits, fatigue lives until crack initiation and the remaining life covered by crack growth until final failure.

theoretical teaching

1. Fatigue as a Phenomenon in the Material.
2. Stress Concentration at Notches.
3. Residual Stress.
4. Stress Intensity Factors of Cracks.
7. Load Spectra and Fatigue under Variable-Amplitude Loading.
8. Fatigue Crack Growth under Variable-Amplitude Loading.
10. Fatigue of Aircraft Structures.
12. The Use of Finite Element Method (FEM) in Fatigue Analysis.
13. The Use of Extended Finite Element Method (XFEM) in Fatigue Analysis.

practical teaching

Practical work will cover analysis of different fatigue specimens and crack growth in aircraft spars under constant and variable amplitude loading. Results obtained in experiments will be
compared to numerical values obtained using FEM and XFEM.

**prerequisite**

No special requirements

**learning resources**

Handouts, Virtual classroom (Moodle), Powerpoint presentations, Recommended literature and websites, Ansys software, Abaqus software

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 5
calculation tasks: 5
seminar works: 0
project design: 5
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 5
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 15
test/colloquium: 15
laboratory exercises: 0
calculation tasks: 0
seminar works: 20
project design: 20
final exam: 30
requirements to take the exam (number of points): 30

**references**
A. Grbovic, Handouts, Faculty of Mechanical Engineering, Belgrade, 2012.
Fatigue Design Methods, Boeing Coorp.
Fiber optical data transfer

ID: MSc-0844
responsible/holder professor: Vasić-Milovanović I. Aleksandra
teaching professor/s: Vasić-Milovanović I. Aleksandra
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

The goal of the course Fiber optical data transfer is to provide basic knowledge of fiber optics, together with the methodology of fiber optical communication technology and mechanical and optical performance evaluation. This course also covers basic principles of fiber optic bobbin design, single mode fiber optic, measurement techniques, classification and characterization. In addition to the above, there is also an introduction of specific optical fibers that are part of fiber optical sensor systems (transmitters and receivers).

learning outcomes

At the end of the course students will have practical knowledge of fiber optic technology and its various applications in data transfer, together with knowledge of fiber optics bobbin production and principles of testing and verification.

theoretical teaching

Theoretical teaching
1. Basic principles of fiber optics
2. Classification and types of fiber optic cables
3. Fiber optic cable preparation
4. Fiber optic cable termination
5. Mechanical splicing
6. Fiber cable design and routing
7. Fiber optic bobbin design principles
8. Fiber optical sensors
9. Measurement techniques and systems
10. Fiber optical transmitters and receivers

practical teaching

Practical teaching
1. Calculation of fiber optic signal distribution
2. Fiber optic bobbin calculation and design
3. Fiber optical data transfer in various applications – laboratory exercises
4. Fiber optic testing (OTDR, Power Meter) - laboratory exercises
5. Fiber optic bobbin testing - laboratory exercises.

prerequisite

There is no obligatory prerequisites.
learning resources


Laboratories
1. Institute of Physics
2. Faculty of Mechanical engineering – Laboratory for guidance and control

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 10
calculation tasks: 4
seminar works: 6
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 2
check and assessment of seminar works: 2
check and assessment of projects: 0
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35
references

Fundamentals of guided missiles navigation systems

ID: MSc-1157
responsible/holder professor: Todić N. Ivana
teaching professor/s: Todić N. Ivana
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

This course is based on the acquisition of knowledge of navigation systems, primarily inertial navigation and a global positioning system, with the goal that the information derived from the navigation systems can be used trajectory guidance or the path correction.

learning outcomes

After this course, the student is trained for independent work in the field of navigation systems and acquires the necessary knowledge to participate in new development projects in this field.

theoretical teaching


practical teaching


prerequisite

none

learning resources

Salychev, O., “Applied Inertial Navigation: Problems and Solutions”, Bauman MSTU Press,
number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 25

active teaching (practical)

auditory exercises: 5
laboratory exercises: 5
calculation tasks: 10
seminar works: 0
project design: 15
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 25
final exam: 45
requirements to take the exam (number of points): 0

references

Gas dynamics and CFD

ID: MSc-1159
responsible/holder professor: Simonović M. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: project design
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

Education of students to apply compressible flow theory to typical aerodynamic problems. Determination of flow parameters based on quasi one-dimensional theory. To be able to apply theory of characteristics to computation of supersonic flow in nozzles and diffusers

learning outcomes


theoretical teaching


practical teaching

Theoretical concepts are illustrated by computational examples. Instead of tables and charts small Matlab programs and Maxima programs are developed and used

prerequisite

learning resources

Classroom, projector, laptop.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 50

active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 10
seminar works: 0
project design: 10
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 3
colloquium, with assessment: 0
test, with assessment: 0
final exam: 2

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 20
seminar works: 0
project design: 60
final exam: 10
requirements to take the exam (number of points): 35

references

Infrared detectors

ID: MSc-0843
responsible/holder professor: Milinović P. Momčilo
teaching professor/s: Milinović P. Momčilo
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

The course Infrared Detectors covers theoretical and practical knowledge regarding principles of operation, design, manufacturing technology and application of infrared photodetectors for night vision/thermal imaging.

learning outcomes

At the end of the course students will have gained practical knowledge necessary to design and use different types of photodetectors for thermal imaging, including mercury cadmium telluride photovoltaic and photoconductive devices.

theoretical teaching

1. Elements of radiometry and photometry
2. Optical properties of systems
3. Fundamental performance of infrared photodetectors
4. Classification of infrared photodetectors
5. Figures of merit
6. Photon management in detectors
7. Noise management
8. Thermal detectors: bolometers, thermopiles and pyroelectric devices
9. Semiconductor (photon) detectors
10. Detection in (3-5) micrometer range: indium antimonide
11. Mercury cadmium telluride PV and PC detectors
12. Design and fabrication of mercury cadmium telluride devices
13. QWIP and QDIP devices
14. Focal plane arrays

practical teaching

1. Calculation of figures of merit of intrinsic semiconductor detector for night vision
2. Calculation of composition profiles for epitaxial mercury cadmium telluride
3. Design of uncooled mercury cadmium telluride detector

prerequisite

There is no obligatory prerequisites.
Passed exam prefered:
- Introduction to optical system design

learning resources

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 12
laboratory exercises: 0
calculation tasks: 12
seminar works: 6
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 2
check and assessment of projects: 0
colloquium, with assessment: 8
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

**references**
Introduction to CFD

ID: MSc-1160
responsible/holder professor: Svorcan M. Jelena
teaching professor/s: Svorcan M. Jelena
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

Educate students to understand and successfully apply various procedures for efficient solution to fundamental partial differential equations derived from Navier-Stokes equations.

learning outcomes

Familiarizing the student with the computational process and available, mostly used numerical methods.
After completing the course, the student will be able to perform engineering simulations based on continuum mechanics.
Understanding of the meaning of a well posed problem and of additional conditions necessary to obtain a unique solution.
Recognition of the most influential causes of the flow behavior.
Overview of the fundamental models, boundary conditions and approximation schemes.
Implementation of personal codes and the usage of existing software to simulate simple flow problems.

theoretical teaching


practical teaching

Each theoretical topic is accompanied by suitable practical examples and programs that illustrate the applied numerical method and results post-processing.

prerequisite

There are no mandatory conditions/prerequisites for course attendance.

learning resources

Classroom, projector, laptop.

number of hours

895
total number of hours: 75

active teaching (theoretical)

lectures: 60

active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 3
colloquium, with assessment: 0
test, with assessment: 0
final exam: 2

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 60
final exam: 30
requirements to take the exam (number of points): 30

references

Additional materials, lecture slides.
Introduction to Neural Networks and Fuzzy Systems

ID: MSc-1151
responsible/holder professor: Jovanović Ž. Radiša

teaching professor/s: Jovanović Ž. Radiša

level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written

parent department: MFB

semester.position: subject offered only in English, without strictly defined position

goals
The objectives of the course are:
• Introduce students to the fundamental principles of artificial neural networks and fuzzy systems.
• Introduction to the neural networks for classification, recognition and regression.
• Understanding of fuzzy approach to modeling phenomenon, process and systems and basic of fuzzy set theory and fuzzy logic.
• Mathematical modeling of artificial neural networks and fuzzy systems and its application to science and technology.
• To offer neural network and fuzzy system implementations in Matlab/Simulink software.

learning outcomes
After completing this course, students will be able to:
• Understand the concepts, and representation of most common neural network models.
• Understand the mathematical and practical concept of fuzzy sets, fuzzy logic and fuzzy system theory.
• Implement neural network models and fuzzy systems for particular applications.

theoretical teaching

practical teaching

PA:
Practical work includes computational exercises that follow the content of course.

PL:

Practice and experiments: computer applications in simulation and implementation of neural networks and fuzzy systems, as well as their practical realization using Matlab and different plants within a modular educational real-time control system (inverted pendulum, ball and beam system, DC servo motor, coupled tanks experiment).

prerequisite

Defined by curriculum of the study programme.

learning resources

• Radiša Jovanović, Introduction to Neural Networks and Fuzzy Systems, Lecture notes, Faculty of Mechanical Engineering.
• Modular educational real time control system with various control plants (DC servo motor, inverted pendulum, double inverted pendulum, heat flow experiment, coupled water tanks experiment), with acquisition hardware and software.
• Installation for control system testing and acquisition of electrical variables
• Intelligent Control Systems Laboratory, Control Systems Laboratory.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 15
laboratory exercises: 10
calculation tasks: 0
seminar works: 5
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5
assessment of knowledge (maximum number of points - 100)

feedback during course study: 10

test/colloquium: 50

laboratory exercises: 0

calculation tasks: 0

seminar works: 10

project design: 0

final exam: 30

requirements to take the exam (number of points): 30

references

Radiša Jovanović, Introduction to Neural Networks and Fuzzy Systems, Lecture notes, Faculty of Mechanical Engineering


Introduction to optical system design

**ID:** MSc-0837  
**responsible/holder professor:** Micković M. Dejan  
**teaching professor/s:** Micković M. Dejan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** MFB  
**semester.position:** subject offered only in English, without strictly defined position

**goals**

The goal of the course Introduction to optical system design is that students learn basic facts about lens design. This means that students will learn the basic theory of geometrical optics such as the paraxial optics and the ideal optics. During course students will start to use standard program for optical design. Knowledge and skill obtained in this course will be used in following advanced courses of optical system design.

**learning outcomes**

At the end of the course students will have practical knowledge of the geometrical optics, optical components (lenses, mirrors, prisms) and optical materials that are necessary for studying other fields of the optical system design.

**theoretical teaching**

1. Conventions in optics  
2. Reflection and refraction on single optical surface  
3. Ideal optics  
4. Basic relations between object and image  
5. Paraxial optics  
6. Optical invariants  
7. Lenses  
8. Mirrors  
9. Prisms  
10. Multiple component optical systems  
11. Diaphragms and pupils of optical system  
12. Physical characteristics of optical materials  
13. Glasses  
14. Special optical materials

**practical teaching**

1. Calculation of the raytrace in the ideal optical system  
2. Calculation of the raytrace in the paraxial optical system  
3. Introduction to the lens design program  
4. Calculation of single lens  
5. Calculation of mirrors and prisms  
6. Calculation of multicomponent system

**prerequisite**
There is no obligatory prerequisites.

**learning resources**

1. Vasiljević D.: Optical instruments and optoelectronics, Faculty of Mechanical Engineering, Belgrade, 2005. (in Serbian)
5. Standard program for lens design

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 12
laboratory exercises: 0
calculation tasks: 12
seminar works: 6
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 2
check and assessment of projects: 0
colloquium, with assessment: 8
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35
references
Liquid propellant engine design

ID: MSc-1104

responsible/holder professor: Milinović P. Momčilo
teaching professor/s: Milinović P. Momčilo
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: seminar works
parent department: MFB

goals

This course provides an overview of the fundamental concepts and technologies of modern liquid propellant rocket engines.

learning outcomes

Students will be introduced to liquid rocket engine principles and technologies. Future engineers who will working on development, design, analysis, and fabrication of thrusters and spacecraft liquid propulsion systems will better understand the place and role of thrusters in the overall spacecraft design - including their interactions and constraints.

theoretical teaching

•Introduction to Liquid-Propellant Rocket Engines
•Engine Requirements and Preliminary Design Analyses
•Introduction to Sample Calculations
•Design of Thrust Chambers and Other Combustion Devices
•Design of Gas-Pressurized Propellant Feed Systems
•Design of Turbopump Propellant Feed Systems
•Design of Rocket-Engine Control and Condition-Monitoring Systems
•Design of Propellant Tanks
•Design of Interconnecting Components and Mounts
•Engine Systems Design Integration
•Design of Liquid-Propellant Space Engines

practical teaching

Practical work consists of presentation of examples and their analysis and discussion of the previously presented theory.

prerequisite

none

learning resources

Moodle (Modular Object-Oriented Dynamic Learning Environment, a free, open-source PHP web application for producing modular internet-based courses that support a modern social constructionist pedagogy).
Lectures, power point presentations, room equipped with computers & software for design and simulations, handouts.
number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 25
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 10
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 0

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 40
project design: 0
final exam: 60
requirements to take the exam (number of points): 40

references

M.Milos .N. DAVIDOVIC , professor's handouts
Maintenance management M

ID: MSc-1233
responsible/holder professor: Bugarić S. Uglješa
teaching professor/s: Bugarić S. Uglješa
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

Perception of position and cost of maintenance within life cycle of technical systems. Acquaint ion with parameters which affect design of maintenance organization. Practical determination and analyze of technical system reliability. Acquaint ion with standard malfunctions, methods for condition monitoring as well as with equipment for condition monitoring. Overwhelm with methods for determination of replacement and reparation strategies, maintenance costs and inventory optimization. Acquaint ion with possibilities of maintenance system optimization and application of computer systems – business solutions.

learning outcomes

Curriculum overcome enables overwhelm with necessary knowledge and skills (models, optimization procedures, monitoring and measure equipment, basics of computer systems – business solutions) for implementation in maintenance organizations of complex technical systems.

theoretical teaching


practical teaching

Seminar work (Analysis of gathered data about malfunction on real system, determination of malfunction intensity, determination of probability density function of time until
malfuction, using chi-square test).
Laboratory work (Acquaintion with standard and advanced equipment for system condition monitoring - SKF, as well as with possibilities of implementation of maintenance module in company computer systems – business solutions, using SAP EAM module).

**prerequisite**

There is no special conditions needed for course attending

**learning resources**

7. Practical instruction in industrial environment (SKF, SAP).
8. Mobile devices for measurement of temperature and vibrations.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 10
calculation tasks: 0
seminar works: 5
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 3
check and assessment of seminar works: 1
check and assessment of projects: 0
colloquium, with assessment: 6
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 40
laboratory exercises: 10
calculation tasks: 0
seminar works: 10
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**

Manufacturing Technologies

ID: MSc-0731
responsible/holder professor: Babić R. Bojan
teaching professor/s: Babić R. Bojan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

This course is designed to provide a basic understanding of present-day manufacturing processes. The course will start by introduction to the manufacturing. Through lectures, demonstrations, and practical applications, the student will be introduced to various manufacturing processes. Further on students will learn basic metal removal processes: turning, milling, boring and grinding. The special attention will be given to CNC machines. Material removal calculations will be introduced for each conventional process including, metal removal rate, depth of cut, cutting forces, spindle and cutting speeds. The most common non-traditional techniques will be considered in detail. Using projects and tutorials, students are motivated to develop and implement process planning skills during the course.

learning outcomes

On the completion of this module students will be able to:
1. Indicate which types of manufacturing process are suited to producing different shapes of product.
2. Indicate which processes are likely to be used for producing a particular product using a specific material or class of material.
3. Describe the advantages and disadvantages of the different classes of manufacturing processes.
4. Demonstrate good team and interpersonal skills to enhance both oral and written communication with colleagues, management and other professionals within the manufacturing industry.

theoretical teaching

Introduction - subject and importance of manufacturing technology in metalworking industry; Fundamentals of metal forming; Bulk deformation processes; Sheet metalworking; Theory of Metal Machining; Machining Operations and Machine Tools; Cutting Tool Technology; Abrasive processes; Non-traditional processes; Economic and Product Considerations in Machining.

practical teaching

Assignment: Example of metal cutting; Assignment: Example of forging; Machining systems for metal cutting (lab work); Machining systems for bulk (lab work). Designing for CNC technology.

prerequisite
Defined by curriculum of study programme/module.

**learning resources**

(1) B. Babic, Handouts, University of Belgrade, Faculty of Mechanical Engineering, 2011.
(2) B. Babic, Electronic classroom for distance learning (http://147.91.26.15/moodle/), University of Belgrade, Faculty of Mechanical Engineering, 2011.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

- lectures: 30

**active teaching (practical)**

- auditory exercises: 0
- laboratory exercises: 22
- calculation tasks: 0
- seminar works: 8
- project design: 0
- consultations: 0
- discussion and workshop: 0
- research: 0

**knowledge checks**

- check and assessment of calculation tasks: 0
- check and assessment of lab reports: 0
- check and assessment of seminar works: 6
- check and assessment of projects: 0
- colloquium, with assessment: 0
- test, with assessment: 4
- final exam: 5

**assessment of knowledge (maximum number of points - 100)**

- feedback during course study: 15
- test/colloquium: 20
- laboratory exercises: 0
- calculation tasks: 0
- seminar works: 35
- project design: 0
- final exam: 30
- requirements to take the exam (number of points): 30

**references**
Matlab and Simulink for engineering applications

ID: MSc-1152
responsible/holder professor: Jovanović Ž. Radiša
teaching professor/s: Jovanović Ž. Radiša
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

After the course the student should be familiar with how Matlab and Simulink are used in solving various engineering tasks. The student should be able to use programming packages MATLAB and Simulink in modeling, analysis, optimization and simulation of various dynamical systems (mechanical, electrical, hydraulic, thermal, and electronic).

learning outcomes

• Acquiring basic and intermediate knowledge in programming tools MATLAB and Simulink.
• Introducing and using methods for modeling, analysis and simulation of various engineering systems.

theoretical teaching


practical teaching

Practical examples that follow the content of course. Modeling, analysis and simulation of various objects on a modular educational real-time control system and acquisition of data from various peripheral devices and sensors with Matlab/Simulink.

prerequisite

Defined by curriculum of the study programme.

learning resources

• Radiša Jovanović, Matlab and Simulink in Automatic Control, Faculty of Mechanical Engineering, Belgrade, 2016.
• PC computers, Computer laboratory, Faculty of Mechanical Engineering Belgrade
• Modular educational real time control system with various plants (DC servo motor, inverted pendulum, double inverted pendulum, heat flow experiment, coupled water tanks experiment), with acquisition hardware and software,
Control Systems Laboratory, Intelligent Control Systems Laboratory.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 30
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 10
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 60
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 0

**references**

Radiša Jovanović, Matlab and Simulink in Automatic Control, Faculty of Mechanical Engineering, Belgrade, 2016.
Missile system integration (SIN)

**ID:** MSc-0906  
**Responsible/Holder Professor:** Milinović P. Momčilo  
**Teaching Professor/s:** Milinović P. Momčilo  
**Level of Studies:** M.Sc. (graduate) academic studies  
**ECTS Credits:** 6  
**Final Exam:** written+oral  
**Parent Department:** MFB  
**Semester Position:** subject offered only in English, without strictly defined position

**Goals**

The basic goals of this course are divided into the informative, education, and expert skill in the tactical, military, missile systems design. First is to inform applicants, and students about different numbers of tactical missile systems based on their military employment. Also, these introducing students into the interactive performances relationships which fully provides joint technology processes on combat platforms integrated with missiles. Educational, as the second goal, are divided as structural, functional, and interactive expert analyses of different knowledge applied on missiles design. Students are preparing for the principals of missiles and rockets mechanics, aerodynamics, chemical propulsion (rocket and air breathing), and others science branches as bases for design missiles subsystems. Expert knowledge goals provide design of subsystems and external and internal loads which determines missiles performances, payload, and ordinance, guidance, flight control and air frame. This basically are considered as function of propulsion types, oriented to the missile mission engagements, and as, the contents of external platforms and subsystems. Skill goals are recognized on the valid evaluation of the most important performances or parameters which determines missile constrains and missiles systems performances both, in employment or development phases. Students have the design tactical and technical requirements, to plan military architecture of systems and achieve skills to recommend the best employment of missiles systems in tactical applications.

**Learning Outcomes**

Students have to accept knowledge about military application of missile systems of tactical levels. Also students have to form experts knowledge about performances of each particular functional subassembly of missiles as linking influenced of missiles flight vehicle, and missile system combat architecture. This expert knowledge understand, also, particular parameters of equipment subassemblies linked with missile, and their constrains influenced on merits of efficiency reliability and cost effective analyses of missile systems. Expert gets skill to design frame of tactical and technical demands for system and component integrations design.

**Theoretical Teaching**

1. Introductive considerations, military diversification of missiles and rockets, and basic elements of integration process in missiles design (tactical performances concepts dimensions, mission requirement, and basic missile-rocket concept)
3. Launcher and Fire Control Systems (FCS) (types of launcher design, initial errors of launching and influence on FCS).
5. The process of developing and implementing tactical missile (the requirements for performance testing missiles, airframe, flight control, guidance, launching, warheads and fuzes and propulsion and power plants).
6. Systems and missiles Testing and Evaluation (types of tests, laboratory tests and external tests, simulation tests, combat tests of payload components, the reliability tests, electromagnetic compatibility, logistic tests and tests using the platform to a different environment, final integration and test planning and flight integration test).

practical teaching

1. Tactical and technical requirements design of missiles (warheads, payload, propulsion, homing head, guidance, control)
2. Tactical and technical requirements of launcher
3. Tactical and technical requirement of command system, targets surveillance systems links and FCS (fire control systems)
4. Tactical design of guidance and navigation control loops

prerequisite

None

learning resources

1. M. Milinovic: Basics of missiles and launchers design (serb), University of Belgrade Faculty of ME 2002., textbook-english handouts
2. M. Milinovic, M. Holclajtner - Basics of missiles design (serb), University of Belgrade Faculty of ME 2004., layhandout

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 10
consultations: 5
discussion and workshop: 5
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 10
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 20
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
final exam: 50
requirements to take the exam (number of points): 0

**references**

Eugene L. Fleeman; Tactical missiles design; AIAA, Education series; US, VA 20191-4344; June 8, 2001
Robert L. McCoy, Modern Exterior Ballistics, 1999 AIAA, USA
M.Milinovic missile systems design, eng, Univ.of Belgrade ,FME,layhandout,2000.
Nozzle Flow Analysis and Thrust Vector Control Systems

**ID:** MSc-0777  
**responsible/holder professor:** Miloš V. Marko  
**teaching professor/s:** Miloš V. Marko  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** MFB  
**semester.position:** subject offered only in English, without strictly defined position

**goals**

Objective of the Course is providing insight in the fundamentals and physics of the nozzle flow as well as insight in mathematical modeling of this phenomena. The Course is set up to deliver engineering tools for advanced propulsion problems and fundamentals of thrust vector systems.

**learning outcomes**

Upon completion and passing the course the student is expected to understand the basic concepts and problems addressed in the field of nozzle flows and Thrust Vector Control Systems. It is expected that the student knows how to apply the acquired knowledge in this field to solve practical engineering problems in the area of propulsion.

**theoretical teaching**


**practical teaching**

Practical part of Course demonstrate the numerical examples in all areas of nozzle applications. Practical work of students is realized through a virtual classroom available 24 hours (program MOODLE). In the workshop students have approach to the professor's written notes, lectures, tests for practice and quizzes (each student works individually).

**prerequisite**

None

**learning resources**
This Course has a virtual classroom on the Internet. At the first lecture students are enrolled and trained for work (Moodle software). In the workshop approach is performed with the lectures and exercises, guidelines for project design, internet resources, etc.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 45

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 0

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 15
test/colloquium: 25
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 0

**references**

Zucrow & Hoffman: Gas Dynamics, Vol 1, Vol 2, John Wiley & Sons, 2005
J.John, T.Keit: Gas Dynamics, Pearson Hall, 2006
Numerical Methods

ID: MSc-1161
responsible/holder professor: Bengin Č. Aleksandar
teaching professor/s: Bengin Č. Aleksandar
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

Purpose of the subject is to introduce basic numerical methods useful in everyday engineering calculations. Applications are illustrated by short MatLab programs. Students are enabled to modify these programs according to their needs.

learning outcomes

After passing this exam students will be capable to understand application of numerical methods applied to solution of engineering problems. Students will be also capable to recognise when certain numerical methods should be applied in engineering applications. Ability to numerically interpolate, integrate, differentiate, solve system of equations, solve ordinary differential equations, apply FFT analysis. Apply Matlab to implement numerical methods.

theoretical teaching

The following topics are contained in this course: Introduction to simulation, Matlab in short, Approximate calculations, Interpolation, Solution of systems of linear algebraic equations, Solution of nonlinear equations, Numerical differentiation, Numerical Integration, Ordinary differential equations, Determination of eigenvalues, Partial differential equations, Finite difference method, Finite volume method.

practical teaching

For each topic are presented one or more MatLab examples (dependent on topic). This examples are used to illustrate solution procedure tied to the topic. Each student get unique combination of problems for each topic which is left as homework. Quality of student response to the problems contribute to final grade of this subject.

prerequisite

None.

learning resources

Computer lab, beam projector, laptop

number of hours

total number of hours: 75

active teaching (theoretical)
lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 5
calculation tasks: 10
seminar works: 0
project design: 10
consultations: 1
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 2
check and assessment of lab reports: 2
check and assessment of seminar works: 0
check and assessment of projects: 3
colloquium, with assessment: 0
test, with assessment: 0
final exam: 2

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 20
seminar works: 0
project design: 40
final exam: 30
requirements to take the exam (number of points): 30

**references**

Lecture notes and lecture slides
Numerical Methods in Heat and Mass Transfer

**ID:** MSc-1236  
**responsible/holder professor:** Milivojević M. Aleksandar  
**teaching professor/s:** Milivojević M. Aleksandar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** MFB  
**semester.position:** subject offered only in English, without strictly defined position

**goals**

The objectives of the subject are to introduce the students with numerical methods in general and with heat and mass transfer problems, in particular and to familiarize students with the CFD elements.

**learning outcomes**

To encourage and enable students to use numerical methods in practice.

**theoretical teaching**

Topics  
1. Introduction to numerical methods.  
2. Conservation equations.  
3. Heat and mass transfer.  
5. Turbulence; Two phase flows.  
6. Boundary conditions; Meshing;  
7. Solution methods.

**practical teaching**

Practical tuition includes analysis and examples of conservation of mass and energy laws, introduction to the CFD, and use of CFD to solve a problem in practical heat/mass transfer situation.

**prerequisite**

Thermodynamics B exam passed

**learning resources**

The subject Handouts

**number of hours**

total number of hours: 75

**active teaching (theoretical)**
lectures: 30

**active teaching (practical)**

auditory exercises: 5
laboratory exercises: 10
calculation tasks: 5
seminar works: 5
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 5
calculation tasks: 5
seminar works: 20
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**

The Handouts
Principles of warhead mechanisms

ID: MSc-0836
responsible/holder professor: Micković M. Dejan
teaching professor/s: Micković M. Dejan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

The main objective of the course is that students get basic knowledge of principles of mechanisms for fragmentation, blast, shaped charge, EFP, KE-rod and special warheads. These fundamentals are important for understanding of projectile design and terminal ballistics.

learning outcomes

Student gets contemporary knowledge about main principles of modern warhead mechanisms. Student understand the physics of fragmentation, blast, shaped charge, KE-rod and special warhead mechanisms and performs fundamental calculations of relevant warhead parameters.

theoretical teaching

Fragmentation warhead principles. Controlled warhead fragmentation. Premade fragments warheads.
Blast warheads.
Influence factors on shaped charge effect. Jet formation theory.
Explosively formed projectiles.
Kinetic energy (KE) rod warheads.
Special warheads.

practical teaching

Fragmentation warhead principles. Safety during the flight. Simulation of warhead action.
Blast warheads. Blast crater characteristics.
Influence factors on shaped charge effect. Simulation of jet formation and penetration.
Explosively formed projectiles. Calculation of velocity of EFP.
Kinetic energy (KE) rod warheads. Selected problems.

prerequisite

No.

learning resources

1. Jaramaz, S.: Warheads Design and Terminal Ballistics, Faculty of Mechanical Engineering,

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 10
seminar works: 5
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

**references**

Production and operations management 1 - M

ID: MSc-1238
responsible/holder professor: Spasojević-Brkić K. Vesna
teaching professor/s: Spasojević-Brkić K. Vesna
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

The aim of this course is to acquire knowledge and practical skills in the field of theory and practice of the production and operations management. Mechanical engineers after taking this course are trained to perform diagnostics and to apply methods for raising the level of enterprise organisation and rationalisation of operations and production. Methods and techniques for production and operations management are useful in everyday tasks of mechanical engineers irrespective of the job specialisation.

learning outcomes

Upon successful completion of this course, student acquires the following competencies: 1. Diagnosing the state of the organisation of the company, 2. Organisational structure design, 3. Tools for rationalisation of production and operations processes application in the company 4. Analysis of the success rate of an enterprise and accordingly are able to diagnose the level of organisation and 5. explain the connection between the above mentioned competencies to make decisions, and, accordingly upon the course completion is able to design organisational structure and make rationalisation of production processes according to calculated success rates. After completion of the course students also demonstrate an awareness and an appreciation of the importance of the operations and production management to the sustainability of an enterprise and are trained to solve real problems using scientific methods and techniques of production and operations management.

theoretical teaching


practical teaching

Design of Macro-organisational structure of manufacturing enterprises with particular emphasis on the organisational structure of the production function micro level. Solution of practical problems in the areas of linear programming, CPM/PERT, inventory management and capacities calculations and production cycle time and capacities measurement. The
corporate performance measures calculation.

prerequisite

learning resources

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 1
laboratory exercises: 0
calculation tasks: 14
seminar works: 0
project design: 10
consultations: 0
discussion and workshop: 5
research: 0

knowledge checks

check and assessment of calculation tasks: 3
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 4
colloquium, with assessment: 2
test, with assessment: 1
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 5
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 15
seminar works: 0
project design: 20
final exam: 30
requirements to take the exam (number of points): 30

references
Production Planning and Control

ID: MSc-1099
responsible/holder professor: Babić R. Bojan

learning outcomes

After successful completion of the course student will able to:
1. Demonstrate and explain the use of Manufacturing Requirements Planning (MRP2), Just-In-Time (JIT) techniques in terms of operation and their importance in Lean World Class Manufacturing.
2. Prepare a work estimate of a specified manufacturing product and explain the importance of value analysis/value management for both product and process design.
3. Explain various production control methods which can be applied to specific situations and state their relationship to the product/process involved.
4. Outline the process and procedures from sales to the shop floor required to obtain an authority to commence production.
5. Apply scheduling and material control techniques to various specified situations. Include an explanation of the need for inventory minimisation procedures and how these might conflict with delivery response objectives.

theoretical teaching

Introduction
Production planning and control: role and impact
Production systems
Classification of production systems
Plant location and layout
Factors influencing plant/facility location
Plant layout
Classification of layouts
Design of product layout
Design of process layout
Material handling
Objectives of material handling
Principles of material handling
Selection of material handling equipment
Principles of Production Planning and Control
Project planning techniques
Operations planning and scheduling systems
Materials requirements planning (MRP)
Enterprise requirements planning (ERP)
Introduction to planning and scheduling
Planning and Scheduling: Role and Impact
Planning and Scheduling Functions in Manufacturing
Manufacturing Models
Jobs, Machines, and Facilities
Processing Characteristics and Constraints
Performance Measures and Objectives
Planning and Scheduling in Manufacturing
Project Planning and Scheduling
Machine Scheduling and Job Shop Scheduling
Scheduling of Flexible Assembly Systems
Economic Lot Scheduling
Planning and Scheduling in Supply Chains

practical teaching

Laboratory work includes computer-aided applications and programming of automated production equipment.

prerequisite

Defined by curriculum of study programme/module.

learning resources

(1) B. Babic, Handouts, University of Belgrade, Faculty of Mechanical Engineering, 2016.
(2) AnyLogic simulation software
(3) B. Babic, Software packages for process planning

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 8
calculation tasks: 3
seminar works: 0
project design: 15
consultations: 4
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 4
colloquium, with assessment: 2
test, with assessment: 4
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 15
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 35
final exam: 30
requirements to take the exam (number of points): 30

**references**

Project Management

ID: MSc-0749
responsible/holder professor: Babić R. Bojan
teaching professor/s: Babić R. Bojan
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: seminar works
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

The management of projects is a key element for successful scientific investigation of activities related to academic research, company research and development or consultancy. Through this course learners will develop an understanding of what constitutes a project and the role of a project manager. They will examine the criteria for the success or failure of a project, evaluate project management systems and review the elements involved in project termination and appraisal.

Learners will also understand the need for structured organisation within the project team, effective control and coordination and good leadership qualities in the project manager. They will be able to analyse and plan the activities needed to carry out the project, including how to set up a project, how to control and execute a project, and how to carry out project reviews using a specialist software package for project management. They will also appreciate how the project fits into the strategy or business plan of an organisation.

learning outcomes

On completion of this unit a learner should:
1 Understand the principles of project management
2 Be able to plan a project in terms of organisation and people
3 Be able to manage project processes and procedures.

theoretical teaching

Project management: project management and the role of the project manager eg management of change, understanding of project management system elements and their integration, management of multiple projects, project environment and the impact of external influences on projects; identification of the major project phases and why they are required; an understanding of the work in each phase; the nature of work in the lifecycles of projects in various industries
Success/failure criteria: the need to meet operational, time and cost criteria; define and measure success, work breakdown structure (WBS), project execution strategy and the role of the project team; consideration of investment appraisal eg use of discount cash flow (DCF) and net present value (NPV); benefit analysis and viability of projects; determine success/failure criteria; preparation of project definition report;
Project management systems: procedures and processes; knowledge of project information support (IS) systems; how to integrate human and material resources to achieve successful projects
Organisational structure: functional, project and matrix organisational structures eg consideration of cultural and environmental influences, organisational evolution during the project lifecycle; job descriptions and key roles eg the project sponsor, champion, manager,
integrators; other participants eg the project owner, user, supporters, stakeholders

Roles and responsibilities: the need for monitoring and control eg preparation of project plans, planning, scheduling and resourcing techniques,

Control and co-ordination: use of work breakdown structures to develop monitoring and control systems, monitoring performance and progress measurement against established targets and plans; project reporting; change control procedures;

Human resources and requirements: calculation; specification; optimisation of human resource requirements; job descriptions

**practical teaching**

Demonstration of project control and reporting techniques by using appropriate project management software. The following phases should be covered: Project initiation phase – Creation of initiation report, Making of conception report, Feasibility report forming.

**prerequisite**

Defined by curriculum of study programme/module.

**learning resources**

Appropriate software packages will be needed to demonstrate project control and reporting techniques. Packages might include time and cost scheduling packages, documentation and procurement control packages, spreadsheet packages, graphic presentation packages.

B. Babic, Electronic classroom for distance learning (http://147.91.26.15/moodle/), University of Belgrade, Faculty of Mechanical Engineering, 2011,

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 22
calculation tasks: 0
seminar works: 8
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 6
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 4
final exam: 5

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 15
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 35
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**

Harvey Maylor, Project Management, Financial Times Press, 2010
Carl Chatfield and Timothy Johnson, Microsoft Office Project 2003 Step by Step, Microsoft Press, 2004
Propellant tanks and pressurization systems

ID: MSc-1103  
responsible/holder professor: Elek M. Predrag  
teaching professor/s: Elek M. Predrag  
level of studies: M.Sc. (graduate) academic studies  
ECTS credits: 6  
final exam: written  
parent department: MFB  
semester.position: subject offered only in English, without strictly defined position

goals

This course is designed for students who wish to acquire an understanding of propellant tanks and pressurization systems - an important subsystem of liquid propellant rocket engines.

learning outcomes

After successful completion of the course, students should be able to:
- fully understand the role of tanks and their pressurization system in the operation of a liquid propellant rocket engine,
- analyze different tank geometries and arrangements,
- calculate the required tank thickness,
- optimize pressurization systems,
- perform initial design of propellant tanks and pressurization systems of liquid rocket engines.

theoretical teaching

1. Propellant tanks - properties and requirements  
2. Categories of tanks in liquid propellant propulsion systems  
3. Tanks, piping, and valves  
4. Typical tank arrangements  
5. Pressurization systems  
6. Subsystems for pressurizing tanks (for both of the two types of feed systems: pressure feed systems and pump feed systems).

practical teaching

Practical work consists of presentation of examples, their analysis and discussion of the previously presented theory.  
1. Propellant tanks as pressure vessels - calculation examples  
3. Tanks, piping, and valves - examples  
4. Typical tank arrangements - analysis of examples  
5. Pressurization systems - examples of pressure regulators  
6. Subsystems for pressurizing tanks - examples for both of the two types of feed systems: pressure feed systems and pump feed systems.

prerequisite

Passed exams (preferred): Fundamentals of projectile propulsion, Strength of materials
learning resources


number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 10
seminar works: 10
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Propulsion Systems

ID: MSc-0980
responsible/holder professor: Miloš V. Marko
teaching professor/s: Miloš V. Marko
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: seminar works
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

Course objective is to introduce students to the types and principles of functioning of propulsion systems, as well as their domains of use. Furthermore, the relation between the type of the flying object and propulsion system is pointed out, so that each mission can be realized in an optimal way according to the desired goals and constraints.

learning outcomes

By mastering this course, a student acquires abilities to perform analysis and synthesis of the whole system that consists of the flying object and its power elements. A student gains knowledge on structures of the various types of propulsion systems and components they are made of. Based on the acquired knowledge on the propulsion systems performances, a student is able to form an opinion on the quality of usually used engines and will acquire knowledge necessary for further self-improvement.

theoretical teaching

Types of the propulsion systems.
Aircraft propulsion systems.
Missile propulsion systems.
Domains of use of certain engine types.
Current problems, trend and perspectives of propulsion.

practical teaching

Practical work consists of presentation of examples and their analysis and discussion of the previously presented theory.
Visiting to propulsion laboratory.

prerequisite

none

learning resources

Moodle (Modular Object-Oriented Dynamic Learning Environment, a free, open-source PHP web application for producing modular internet-based courses that support a modern social constructionist pedagogy).
Lectures, power point presentations, room equipped with computers & software for design and simulations, handouts.
**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 25
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 10
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 0

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 40
project design: 0
final exam: 60
requirements to take the exam (number of points): 40

**references**

M.Milos, professor's handouts
Quality Assurance and Tests

ID: MSc-1162
responsible/holder professor: Peković M. Ognjen
teaching professor/s: Peković M. Ognjen
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

To educate students to design, survey and study quality systems of products and services.
To educate students to design measuring testing procedure to estimate quality of manufactured product.

learning outcomes

Ability to design and lead quality system of products and services.
Able to distinguish between quality control and quality assurance.
Able to apply quality system standard.
Ability to project quality planning, quality plan, inspection and test plan.
Able to develop and prepare quality system documents.
Understand and apply certification process.

theoretical teaching

Introduction to quality assurance and quality control.
Methods and means of Quality control.
Quality and value, different views of quality.
Probability and statistics.
Estimation of statistic parameters.
Sampling Theory, Confidence intervals, Hypothesis tests.
Measurements, tolerances and quality.
Statistical quality control.
Quality management.

practical teaching

Each topic is illustrated by practical examples.
After each topic students prepare answer to homework requirements.
Final exam is presentation of seminar work done during semester.

prerequisite

No prerequisites.

learning resources

Laptop, Beam projector

number of hours
total number of hours: 75

**active teaching (theoretical)**

lectures: 50

**active teaching (practical)**

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 3
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 2

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 50
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

**references**

Lecture Notes and Lecture Slides
Seekers

**ID:** MSc-1156  
**responsible/holder professor:** Todić N. Ivana  
**teaching professor/s:** Todić N. Ivana  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** MFB  
**semester.position:** subject offered only in English, without strictly defined position

**goals**

Acquiring knowledge in the field of missile seekers with the possibility of applications in the fields of research and development, designing, manufacturing, marketing, operational use and analysis of modern missile seekers.

**learning outcomes**

The student acquires general knowledge in the areas of analysis and design of missile seekers that enables participation and communication in work teams involved in the development of guided missiles. It has acquires knowledge in the areas of testing of missile guidance system, specially seekers and integration with missile guidance system.

**theoretical teaching**


**practical teaching**

Basic principle of seeker calibration. Hardware in the loop test with different types of seekers.

**prerequisite**

none

**learning resources**

Handouts,  
Principles of Infrared Technology: A Practical Guide to the State of the Art  

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 25
active teaching (practical)

auditory exercises: 5
laboratory exercises: 10
calculation tasks: 5
seminar works: 15
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 25
project design: 0
final exam: 45
requirements to take the exam (number of points): 0

references

M. Henini, M. Razeghi, Handbook of Infra-red Detection Technologies, Elsevier 2002
Skill Praxis M

ID: MSc-1235
responsible/holder professor: Miloš V. Marko
teaching professor/s: Miloš V. Marko
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 4
final exam: seminar works
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

Practical experience in ambient similar to the ambient where the graduated student - mechanical engineer will realize his own professional carrier.
Preferable almost obligatory: practical work needs to be close connected with subject of MSc thesis.

learning outcomes

Students acquire necessary experience and/or data to successfully finish MSc thesis.
Student may be introduced in business communication, design processes, development processes and manufacturing.
Students can reach practical experiences about the organization and functioning the business systems that deal in mechanical engineering.

theoretical teaching

practical teaching

prerequisite

learning resources

Initial resources are laboratories that belong to the Mechanical faculty.

number of hours

total number of hours: 90

active teaching (theoretical)

lectures: 0

active teaching (practical)

auditory exercises: 0
laboratory exercises: 45
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 45
knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 0

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 70
project design: 0
final exam: 30
requirements to take the exam (number of points): 0

references
Solid propellant motor design

ID: MSc-1105
responsible/holder professor: Elek M. Predrag
teaching professor/s: Elek M. Predrag
level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB
semester.position: subject offered only in English, without strictly defined position

goals

The course is designed for students who wish to acquire an understanding of the fundamental concepts and basic analyses of solid propellant motor performances. It will provide an introduction to the design of this type of rocket propulsion units.

learning outcomes

After successful completion of the course, students should be able to:
- fully understand operational principle and the role of all subsystems of a solid propellant rocket motor,
- understand main properties of different types of solid propellants,
- define and analyze the burning rate of solid propellants,
- independently calculate the “interior ballistics” of a solid propellants rocket motor,
- analyze different propellant grain configurations,
- perform initial design of solid propellant rocket motor.

theoretical teaching

1. Fundamental concepts and main parts of solid propellant rocket motors
2. Nozzle gas flow
3. Thrust of a rocket motor
4. Solid propellant burning rate
5. Pressure in the motor chamber
6. Influence of the initial temperature
7. Nozzle design
8. Propellant grain configurations
9. Motor design practices
10. Testing and verification

practical teaching

Practical work consists of presentation of examples, their analysis and discussion of the previously presented theory.
1. Nozzle gas flow, examples of calculations of an ideal rocket motor
2. Thrust of a rocket motor, examples (influencing parameters)
3. Determination of the main performance parameters from experimental data
4. Solid propellant burning rate (influences of initial temperature, erosive burning)
5. Applications of the equilibrium pressure equation
6. Propellant grain configurations (calculation of cylindrical grain, star, etc.)
7. Testing techniques
prerequisite

Passed exams (preferred): Fundamentals of projectile propulsion, Thermodynamics B

learning resources


number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 10
laboratory exercises: 0
calculation tasks: 10
seminar works: 10
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 5
test, with assessment: 0
final exam: 5

assessment of knowledge (maximum number of points - 100)

feedback during course study: 10
test/colloquium: 30
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Solid-state lasers

ID: MSc-0842  
**responsible/holder professor:** Micković M. Dejan  
**teaching professor/s:** Micković M. Dejan  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** MFB  
**semester.position:** subject offered only in English, without strictly defined position

**goals**

The goal is to introduce students to basic principles of Solid state laser design. After short introduction to light emission, absorption and amplification, students will learn the physics of solid state active materials, laser resonators, laser pumping, amplification and heat removal, as well as physics of short and ultra short pulse generation. During the course a series of demonstration experiments will be presented.

**learning outcomes**

At the end of the course students will have theoretical and practical knowledge of the solid-state laser design. They will be able to understand the principles of modern laser design and to actively do the research of their own.

**theoretical teaching**

1. Absorption, spontaneous and stimulated emission of radiation  
2. Basic principles of light amplification (3 and 4 level systems)  
3. Active materials for solid-state lasers  
4. Laser resonator analysis and design (longitudinal and transverse modes)  
5. Pumping of solid-state laser (using lamps or laser-diodes)  
6. Heat removal and thermal effects  
7. Q-switching and short pulse generation  
8. Mode-locking and ultra-short laser pulses generation  
9. Laser-induced damage  
10. Key applications of solid state lasers (material processing, rang-finding, medical...)

**practical teaching**

1. Diode pumped Nd-YAG laser alignment and output parameter measurement  
2. Second harmonic generation in a Nd-YAG laser  
3. Measurement of Erbium-glass laser parameters  
4. Experimental analysis of a laser resonator, longitudinal and transverse modes  
5. Q-switching in a pulsed Nd-YAG laser; pulse parameter measurement.

**prerequisite**

There is no obligatory prerequisites.

**learning resources**

All practical teaching will be given in the Laboratory for holography, optical materials and photonic crystals, Photonics Center, Institute of Physics, University of Belgrade.

**Number of hours**

Total number of hours: 75

**Active teaching (theoretical)**

Lectures: 30

**Active teaching (practical)**

Auditory exercises: 0
Laboratory exercises: 25
Calculation tasks: 0
Seminar works: 5
Project design: 0
Consultations: 0
Discussion and workshop: 0
Research: 0

**Knowledge checks**

Check and assessment of calculation tasks: 0
Check and assessment of lab reports: 0
Check and assessment of seminar works: 2
Check and assessment of projects: 0
Colloquium, with assessment: 8
Test, with assessment: 0
Final exam: 5

**Assessment of knowledge (maximum number of points - 100)**

Feedback during course study: 10
Test/Colloquium: 30
Laboratory exercises: 0
Calculation tasks: 0
Seminar works: 30
Project design: 0
Final exam: 30
Requirements to take the exam (number of points): 35

**References**

Faculty of Mechanical engineering — course catalog — M.Sc. (graduate) academic studies
Structural Analysis

**ID:** MSc-0735  
**responsible/holder professor:** Grbović M. Aleksandar  
**teaching professor/s:** Grbović M. Aleksandar  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** MFB  
**semester.position:** subject offered only in English, without strictly defined position

**goals**

Primary objectives of the course are as follows:
1. To understand the role of analysis in the structural design process  
2. To understand the theory that underlies the classical methods of analysis  
3. To become proficient in applying the classical methods of analysis  
4. To learn a general framework for structural analysis (which includes modeling, selection of method, application of method and checking of results).  
5. To understand the role of FEM in the structural analysis problems  
6. To learn how to use ANSYS in solving simple 2D and 3D structural problems

**learning outcomes**

This course will give students a sense of how the methods of structural analysis can be used, not only to calculate the response of structures that have already been defined, but also to develop a more fundamental understanding of structural behaviour that can be used in design.

By completing the course, students will acquire a foundation of knowledge of completed works of structural engineering and will be able to solve fundamental structural problem using software for finite element analysis (ANSYS).

**theoretical teaching**

1. Introduction  
   - Review of basic concepts  
   - Equilibrium Equations  
   - Constitutive Relations/Force-displacement Relations  
   - Compatibility Conditions  
2. Analysis of Statically Determinate Structures  
   - SF,BM diagrams  
   - Determination of forces in trusses, frames and cables  
3. Principle of virtual work  
4. Energy Principle  
5. Maxwell's and Betti's laws  
6. Computation of Displacements  
   - Moment area method  
   - Virtual work methods  
7. Introduction to statically Indeterminate Structures  
   - Concept of static and kinematic indeterminacy  
   - Determination of static and kinematic redundancy  
8. Force Method - Introduction and Applications
- Axially loaded members
- Plane truss
- Beams
- Frames
9. Introduction to FEM
10. Application of FEM in structural analysis using ANSYS software
11. Problems solved in ANSYS (step-by-step guides)
12. The use of ANSYS for the formulation and solution of various types of finite element problems

practical teaching

FEA & ANSYS Mechanical APDL

1. ANSYS Mechanical Basics

2. General Analysis Procedure

3. Creating the Solid Model and the Finite Element Model

4. Defining Material Properties and Applying Loads

5. Solution Process

6. Postprocessing

7. Structural Analysis (2D and 3D examples)

8. Importing Geometry from CAD/CAM softwares

9. Producing Reports and Batch files

prerequisite

No specific requirements

learning resources

Handouts, Virtual classroom (Moodle), Powerpoint presentations, Computers with ANSYS software, Recommended literature and websites

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 20
laboratory exercises: 0
calculation tasks: 10
seminar works: 0
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 5
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 3
test, with assessment: 3
final exam: 4

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 10
test/colloquium: 20
laboratory exercises: 0
calculation tasks: 20
seminar works: 0
project design: 0
final exam: 50
requirements to take the exam (number of points): 30

**references**

A. Grbovic, Handouts, Faculty of Mechanical Engineering, Belgrade, 2012.
Thrust chambers and gas generators

**ID:** MSc-1102  
**responsible/holder professor:** Milinović P. Momčilo  
**teaching professor/s:** Milinović P. Momčilo  
**level of studies:** M.Sc. (graduate) academic studies  
**ECTS credits:** 6  
**final exam:** seminar works  
**parent department:** MFB  
**semester.position:** subject offered only in English, without strictly defined position

**goals**

Course objective is to introduce students about the main subsystems of a liquid rocket engines such as thrust chambers and gas generators. More detailed description of the thrust chamber assembly, the injector head, the ignition system and the combustion chamber as well as gas generators.

**learning outcomes**

By mastering this course, a student acquires abilities to understand importance of thrust chambers and gas generators as crucial parts of liquid rocket engines and also to perform their initial design.

**theoretical teaching**

The key components of a liquid propellant rocket engine are the devices for propellant delivery, the turbines and pumps as well as the generators of the driving gases, i.e. gas generator or pre-burner, the propellant injection system, the thrust chamber which combines the combustion chamber and a short part of the diverging section of the nozzle which typically ends with a distribution manifold for the propellants used as coolant for the thrust chamber liner, and, finally the thrust nozzle.

Typical Thrust Chamber

**Characteristic Data**

**Engine Cycles, Performance**

**Design Criteria and Approach**

**Propellant Injection**

**Ignition Concepts**

**Thrust Chamber Heat Fluxes**

**Hot Gas Side Heat Transfer**

**Coolant Side Heat Transfer**

**Heat Transfer Predictions**

**Materials and Processes**

**Gas Generators**

**Design Methodology**

**practical teaching**

Practical work consists of presentation of examples and their analysis and discussion of the previously presented theory.

**prerequisite**
learning resources

Moodle (Modular Object-Oriented Dynamic Learning Environment, a free, open-source PHP web application for producing modular internet-based courses that support a modern social constructionist pedagogy).
Lectures, power point presentations, room equipped with computers & software for design and simulations, handouts.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 15
project design: 0
consultations: 0
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 10
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 0

assessment of knowledge (maximum number of points - 100)

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 40
project design: 0
final exam: 60
requirements to take the exam (number of points): 40

references
N.DAVIDOVIC, ASSISTANT’s handouts
Wind Tunnel Testing

ID: MSc-1158
responsible/holder professor: Peković M. Ognjen

level of studies: M.Sc. (graduate) academic studies
ECTS credits: 6
final exam: written
parent department: MFB

goals

Introduction to wind tunnel testing methodology. Introduction to specifics of various wind tunnel testings. Calibration, reduction and correction of measured data.

learning outcomes

Ability to organize wind tunnel measurements. Application of aerodynamic testing methodology. Ability to collect and reduce relevant data in wind tunnel measurement. Ability to apply correction and calibration procedures. Ability to design pressure, temperature, and force measurement systems. Ability to setup necessary wind tunnel parameters for specific measurements. Ability to implement and specify wind tunnel instrumentation. Ability to report and present measured data.

theoretical teaching


practical teaching


prerequisite

course in aerodynamics or fluid mechanics

learning resources

Wind tunnel, PIV, Pitot tubes, sensors, balances.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 35

active teaching (practical)
auditory exercises: 0
laboratory exercises: 0
calculation tasks: 15
seminar works: 15
project design: 0
consultations: 5
discussion and workshop: 0
research: 0

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 5
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 0

assessment of knowledge (maximum number of points - 100)

feedback during course study: 15
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 30
project design: 0
final exam: 55
requirements to take the exam (number of points): 30

references

M.Sc. thesis

**ID:** MSc-0822  
**Responsible/Holder Professor:** professor of the course which student chooses for the M.Sc. thesis  
**Teaching Professor/s:** the same remark as above  
**Level of Studies:** M.Sc. (graduate) academic studies  
**ECTS Credits:** 26  
**Final Exam:** printed document + oral defense  
**Parent Department:** MFB  
**Semester Position:** 4.2

**Goals**

Applying engineering knowledge, techniques and skills in order to identify, formulate and solve the given engineering task within the Master thesis; understanding the principles of project and equipment design and the environment necessary for their production; designing systems, components or processes bearing in mind practical limitations, such as economic, ecological, social, ethical, health and security limitations; using computing and statistical methods, simulations and information technologies for analysis and synthesis of technological systems; implementing standard tests and measuring and providing an overview of the results. The preparation of Master thesis helps the student to acquire experience in academic paper writing and develop the ability to publicly present the results of independent work, as well as to provide answers to the questions related to the topic of the paper.

**Learning Outcomes**

Upon the successful defence of the Master thesis, engineers should be able to:
• come up with and apply the solutions based on their knowledge in sciences, engineering, technology and mathematics,
• determine, formulate, analyze and solve basic engineering problems,
• design a system, component or process, provide answers to the stated needs, plan and conduct an experiment and analyze and interpret data,
• work efficiently as individuals in a team and in a multidisciplinary environment, with the ability of lifelong learning,
• communicate efficiently with the engineering community and the society as a whole,
• apply the acquired knowledge in practice.

**Theoretical Teaching**

It is developed individually in accordance with the needs and the field encompassed by the topic of the Master thesis. Upon agreement with the mentor, the student compiles the Master thesis in written form, in keeping with the prescribed Faculty standards. The student prepares and publicly defends the written Master thesis upon agreement with the mentor. The student studies the referent literature, bachelor and master theses with similar topics and conducts analyses in order to find solutions to the specific task defined by the topic of the Master thesis.

**Practical Teaching**

Within the given topic, the student may conduct standard testing and measuring; he/she may conduct, analyze and interpret experiments and implement experimental results to process
improvement. He/she may use the methods and tools for analysis, synthesis and design, such as: CAD, CAM, CAE, FEA, FMEA et al.

**prerequisite**

Defined by the curriculum of the study programme/module, the student must have passed the exam of the course which the Master thesis belongs to.

**learning resources**

Existing laboratory equipment at the Faculty, textbooks and library references.

**number of hours**

total number of hours: 330

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 270
consultations: 15
discussion and workshop: 0
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 0
check and assessment of seminar works: 0
check and assessment of projects: 13
colloquium, with assessment: 0
test, with assessment: 0
final exam: 2

**assessment of knowledge (maximum number of points - 100)**

feedback during course study: 0
test/colloquium: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 70
final exam: 30

requirements to take the exam (number of points): 70

**references**
Current textbooks, magazines, library references in the field of the topic of the Master thesis.