Table of contents

Table of contents

B.Sc. work
Aerodynamic Constructions
Aerodynamics
Aircraft propulsion and systems
Computational methods in aeronautics
Design and Technology of Airplane Manufacture
FEM Analysis
Fundamentals of aerotechnics
Introduction to engineering simulations
Light and Composite Structures
Mechanics of Flight
Skill Praxis B - VAZ
Structural Analysis of Flying Vehicles
Theory of Elasticity
Windturbines
Automation Systems Programming
Computer Control Systems
Digital systems
Fundamentals of Clinical Engineering
Fundamentals of Control Engineering
Measurement in control systems
Biomaterials foundations
Combustion and sustainable development B
Combustion B
Engineering Materials 1
Engineering materials 2
Fuel, Lubricants and Industrial Water
Skill Praxis B - ZZK
Tribology
Tribotechnique
Fluid mechanics B
Hydraulics and pneumatics
Fundamentals of Technical Innovation
Machine elements 1
Machine elements 2
Mechanical Engineering Praxis
Skill Praxis B - DUM
Skill Praxis B - MFB
<table>
<thead>
<tr>
<th>Course Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basics of fluid flow measurement techniques</td>
<td>106</td>
</tr>
<tr>
<td>Fundamentals of turbomachinery</td>
<td>109</td>
</tr>
<tr>
<td>Pumps and fans</td>
<td>112</td>
</tr>
<tr>
<td>Skill Praxis B - HEN</td>
<td>115</td>
</tr>
<tr>
<td>English 1</td>
<td>118</td>
</tr>
<tr>
<td>English 2</td>
<td>120</td>
</tr>
<tr>
<td>Sociology and Economy</td>
<td>122</td>
</tr>
<tr>
<td>Industrial ergonomics</td>
<td>125</td>
</tr>
<tr>
<td>Maintenance management</td>
<td>128</td>
</tr>
<tr>
<td>Production and Operations Management 1</td>
<td>131</td>
</tr>
<tr>
<td>Production process optimization</td>
<td>134</td>
</tr>
<tr>
<td>Skill Praxis B - IIE</td>
<td>137</td>
</tr>
<tr>
<td>Basic WEB projecting</td>
<td>140</td>
</tr>
<tr>
<td>Database Design</td>
<td>143</td>
</tr>
<tr>
<td>Engineering communication</td>
<td>146</td>
</tr>
<tr>
<td>Information integration of business functions</td>
<td>149</td>
</tr>
<tr>
<td>Skill Praxis B - MIT</td>
<td>153</td>
</tr>
<tr>
<td>Software engineering 1</td>
<td>155</td>
</tr>
<tr>
<td>WEB projecting in mechanical engineering</td>
<td>158</td>
</tr>
<tr>
<td>Elements of Construction and Mining Machines</td>
<td>161</td>
</tr>
<tr>
<td>Fundamentals of steel structures</td>
<td>164</td>
</tr>
<tr>
<td>Material Handling Equipment</td>
<td>166</td>
</tr>
<tr>
<td>Skill Praxis B - TKL</td>
<td>169</td>
</tr>
<tr>
<td>Computational tools</td>
<td>171</td>
</tr>
<tr>
<td>Programming in C</td>
<td>174</td>
</tr>
<tr>
<td>Mathematics 1</td>
<td>176</td>
</tr>
<tr>
<td>Mathematics 2</td>
<td>179</td>
</tr>
<tr>
<td>Mathematics 3</td>
<td>182</td>
</tr>
<tr>
<td>Numerical methods</td>
<td>185</td>
</tr>
<tr>
<td>Biomechanics of locomotor system</td>
<td>188</td>
</tr>
<tr>
<td>Mechanics 1</td>
<td>191</td>
</tr>
<tr>
<td>Mechanics 2</td>
<td>194</td>
</tr>
<tr>
<td>Mechanics 3</td>
<td>197</td>
</tr>
<tr>
<td>Theory of Mechanical Vibrations</td>
<td>200</td>
</tr>
<tr>
<td>Fundamentals of Motor Vehicles</td>
<td>203</td>
</tr>
<tr>
<td>Skill Praxis B - MOV</td>
<td>206</td>
</tr>
<tr>
<td>Vehicle Design 1</td>
<td>208</td>
</tr>
<tr>
<td>Vehicle Dynamics</td>
<td>211</td>
</tr>
<tr>
<td>Vehicles Safety</td>
<td>214</td>
</tr>
<tr>
<td>Vehicle systems</td>
<td>217</td>
</tr>
<tr>
<td>Buoyancy and Stability of Ship 1</td>
<td>219</td>
</tr>
</tbody>
</table>
Ship equipment
Ship Structures 1
Ship systems
Skill Praxis B - BRO
Electrical engineering
Electronics
Electronics and biomedical measurements
Physics and Measurements
Mechanical Design of Process Equipment
Pipeline and fittings
CAD/CAM SYSTEMS
Computer Graphics
Computer simulation and artificial intelligence
Manufacturing Technology
Production technology and metrology
Fundamentals of Rail Vehicles
Life cycle of Railway Vehicles
Railway Systems
Skill Praxis B - ZEM
Theory of Traction
Strength of materials
Fundamentals of Strength of Structures
Aesthetic Design
Basic technological operations in food industry
CONSTRUCTIVE GEOMETRY AND GRAPHICS
Engineering Graphics
Hidraulic and Pneumatic Mechanisms and Piping
Mechanisms Design
Skill Praxis B - PRM
Introduction to Energetics
Skill Praxis B - TEN
Heating technique fundamentals
Skill praxis B - TTA
Thermodynamics B
Classical Armament Design
Flight Mechanics of the projectile
Fundamentals of Projectiles Propulsion
Fundamentals of Weapon System Design
Introduction to Weapon Systems
Missile weapon design
Skill Praxis B - SIN
B.Sc. work

ID: MSc-0361
responsible/holder professor: professor of the course which student chooses for the B.Sc. thesis
teaching professor/s: the same remark as above
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: printed document + oral defense
parent department: MFB
semester.position: 6.5

goals

Applying the acquired knowledge and methods in order to solve the given tasks within the chosen field. The task refers to studying the problem, its structure and complexity, and coming up with adequate solutions. The student acquires knowledge on the manner, structure and form of writing a project-report which refers to the activities undertaken within the given topic of the Final course. The student acquires the adequate level of knowledge, skills and competences referring to the problem field, implemented methods and obtained results. The student also acquires the ability to publicly present the results of independent work, organised in an appropriate form.

learning outcomes

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

• apply the previously acquired knowledge in the studied fields,
• recognise the structure of the given problem, suggest system analysis and define the directions for its solving,
• expand the knowledge in the field of the selected topic based on their own use of literature,
• briefly describe the solution of the given task and present it on their own,
• communicate efficiently with the engineering community and the society as a whole.

theoretical teaching

It is developed individually in accordance with the related field of the topic of the Final course. Upon agreement with the course teacher, the student defines the task, which points towards the necessary theoretical knowledge that has been acquired and possibly new knowledge that has yet to be acquired for the given task to be solved.

practical teaching

Practical teaching contents refer to the implementation of the acquired knowledge through laboratory exercises, Skill Praxis B and professional visits to companies and factories, related to the field of the topic of the Final course.

prerequisite

The student must have passed the exam of the course the course report belongs to.

learning resources
Existing laboratory equipment, textbooks and library references.

**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: 15
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: 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): 40

**references**

Current textbooks and magazines related to the field of the topic of the Final course.
**Aerodynamic Constructions**

**ID:** MSc-0942  
**responsible/holder professor:** Kostić A. Ivan  
**teaching professor/s:** Kostić A. Ivan, Kostić P. Olivera, Mitrović B. Časlav  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** aerospace engineering  
**semester.position:** 4.4

**goals**

The aim of this course is to introduce students to basic concepts of applied aerodynamics in the domain of subsonic and lower transonic speeds. The emphasis is on the aerodynamics of aircraft, where the aerodynamic characteristics of airfoils, lifting surfaces, and of complete airplane configurations are analyzed. Students will also be introduced to the fundamentals of propeller aerodynamics, as well as of the aircraft lifting surface controls.

**learning outcomes**

After passing the course, the student is expected to understand the fundamental laws of aerodynamics and to possess the knowledge of how to apply them for the solution of practical problems. It is expected that the student will be able to perform basic aerodynamic analyses of airfoils and lifting surfaces, as well as to determine the polar curve for the entire airplane in cruising configuration, at subsonic and lower transonic speeds.

**theoretical teaching**

The course consists of theoretical and practical part. Theoretical part covers the following topics: - introduction: the role and the case study of aerodynamics, aerodynamics in aeronautical and non-aeronautical applications, aerodynamic force and aerodynamic moment, international standard atmosphere; - airfoils (basic geometric characteristics, notation and families, as well as the parameters which define their aerodynamic characteristics); - lifting surfaces of finite aspect ratio (geometric and aerodynamic characteristics); - compressibility effects and their influence at higher subsonic and transonic speeds; - determination of polar curves for the complete aircraft in cruising configuration at subsonic and lower transonic speeds; - design features and aerodynamic characteristics of propellers; - control surfaces (ailerons, flaps, slots, air brakes); - aircraft aerodynamic design schemes.

**practical teaching**

Practical part of the course demonstrates numerical examples in the areas covered by lectures. Practical work of students is accomplished through a virtual classroom available 24 hours (internet - software MOODLE). In the workshop students have access to the professor’s lectures in form of handouts, assignments and tests for practice. Practical training includes two homeworks (one individual and one collective, within the groups to which students are divided). In the first homework student performs calculations of the aerodynamic characteristics of the airplane (polar curve for cruising flight configuration), and the second is the seminar work which is publically presented. Practical training also includes the excursion - visit to the Aviation Museum - Surčin.
prerequisite

None.

learning resources

The Course includes a virtual classroom, accessible by Internet. The MOODLE software is used. Students are enrolled electronically into the classroom and have access to the professor’s handouts, quizzes and additional materials advised by the professor.

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: 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: 3
check and assessment of projects: 2
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: 0
seminar works: 20
project design: 20
final exam: 30
requirements to take the exam (number of points): 25

references
I. Kostić: Aerodynamic constructions, Handouts, University of Belgrade, Faculty of Mechanical Engineering, Belgrade 2014.
Aerodynamics

ID: MSc-0943
responsible/holder professor: Bengin Č. Aleksandar
teaching professor/s: Bengin Č. Aleksandar, Kostić A. Ivan, Kostić P. Olivera, Mitrović B. Časlav
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 2
final exam: written
parent department: aerospace engineering
semester.position: 5.4

goals

The aim of the course is that students become familiar with the basic laws of aerodynamics and its application in solving practical problems. Particularly with the specific features in the compressible flow. Students will learn the basic aerodynamic aircraft configurations for different speeds, as well as the basics of aerodynamics of the vehicle. In the course students obtain basic knowledge in the field of experimental aerodynamics and its application in aerodynamic testing of the aeronautical and non-aeronautical objects.

learning outcomes

Mastering the course, the student acquires knowledge in the field of aerodynamics, with emphasis on the domain of compressible flow, as well as an understanding of the basic aerodynamic configurations of aircraft and aerodynamics of the road vehicle. He also mastered the basics of experimental aerodynamics and its application not only in the aeronautic, but also in other branches of engineering.

theoretical teaching

Lesson 1: Modeling of the flow field
Lesson 2: Compressible flow and waves in compressible flow
Lesson 3: Aerodynamic configurations of the aircrafts and road vehicles
Lesson 4: Subsonic, transonic and supersonic wind tunnels
Lesson 5: Methods of the measurement in wind tunnel tests

practical teaching

In the practical part of teaching it is demonstrated the application of the theoretical law, by solving and analysis of selected numerical examples. The practical work of students is realized by compulsory exercises and by a virtual workshop available 24 hours (MOODLE). In the virtual workshop for students are available professor's lecture notes, assignments for practice and tests for knowledge check. The practical part of the course includes consultations for homework, students work collectively within the small groups (up to five students per group).

prerequisite

Without prerequisites, but it is recommended to pass the exam of the course Aerodynamic constructions previously.

learning resources
Lectures in electronic form, internet resources.

**number of hours**

total number of hours: 30

**active teaching (theoretical)**

lectures: 12

**active teaching (practical)**

auditory exercises: 5  
laboratory exercises: 0  
calculation tasks: 0  
seminar works: 0  
project design: 0  
consultations: 5  
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: 1  
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: 18  
test/colloquium: 32  
laboratory exercises: 0  
calculation tasks: 0  
seminar works: 20  
project design: 0  
final exam: 30  
requirements to take the exam (number of points): 21

**references**
Aircraft propulsion and systems

ID: MSc-1076

responsible/holder professor: Petrović B. Nebojša

teaching professor/s: Peković M. Ognjen, Petrović B. Nebojša, Fotev G. Vasko

level of studies: B.Sc. (undergraduate) academic studies

ECTS credits: 6

final exam: oral

parent department: aerospace engineering

semester.position: 6.3

goals

The task of the course is to introduce students with aircraft equipment and power systems, particularly with their functions, structures and basic principles. The course should give students a global view of all of the aircraft and power systems as well as their interconnection and integrity.

learning outcomes

Through the course students gain the ability to understand the various types of existing aircraft and power systems solutions. They gain knowledge about the different types of aircraft and power system structures. This gained knowledge should allow students who choose other fields of aerospace engineering to better understand the problems involved with aircraft and power systems and should present a good base for students who choose to specialize further in this area.

theoretical teaching

Aircraft hydraulic systems, aircraft fuel systems, aircraft pneumatic systems, aircraft environmental systems, aircraft anti-icing systems, aircraft electrical systems, aircraft cabin systems, avionics, aircraft control systems, aircraft safety systems, aircraft automatic control systems, systems design and development, helicopter systems, power systems structures and their integrity, advanced systems, powerplant fuel system, powerplant hydraulic system, elements and methods for powerplant operation measurements.

practical teaching

Practical teaching is related to presentation of sample problems, analysis and discussion with students in the fields previously treated theoretically. Aircraft hydraulic systems, aircraft fuel systems, aircraft pneumatic systems, aircraft environmental systems, avionics, aircraft control systems, aircraft safety systems, aircraft automatic control systems, systems design and development, helicopter systems, power systems structures and their integrity, advanced systems, powerplant fuel system, powerplant hydraulic system, elements and methods for powerplant operation measurements.

prerequisite

Declared by the curriculum of study program / module.

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: 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: 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): 30

**references**
Computational methods in aeronautics

ID: MSc-1074  
responsible/holder professor: Peković M. Ognjen  
teaching professor/s: Peković M. Ognjen, Svorcan M. Jelena, Simonović M. Aleksandar  
level of studies: B.Sc. (undergraduate) academic studies  
ECTS credits: 4  
final exam: oral  
parent department: aerospace engineering  
semester.position: 5.4

goals

Introducing students to the basics of computer applications in simulations and computations of aeronautical problems. Students are first introduced to theoretical foundations of computational methods and later through computer implementation on model problems from different areas of aeronautical engineering (aerodynamics, flight mechanics, aircraft structures...) gain working knowledge. The subject is organized so that several typical (model) problems are completely solved step-by-step from start to finish.

learning outcomes

By mastering the curriculum a student gains specific skills:
- thorough knowledge and understanding of numerical methods
- ability to use and apply basic numerical methods for solving ODE, finite difference and finite elements methods
- correlation between fundamentals in mathematics, programming, mechanics, fluid mechanics and construction analysis

theoretical teaching

- Determination of geometrical characteristics of sections
- Parameters of compressible flow - Fundamental equations for one-dimensional compressible flow
- Calculation of the flow around a cone (example of solving a problem modeled by ODE)
- Simulation of plane take-off (also example of solving a problem modeled by ODE, application of interpolation methods to aerodynamic characteristics of aircrafts)
- FEM calculation of lattice structures (example of solving sparse systems of equations with many unknowns)

practical teaching

- Determination of geometrical characteristics of sections - using a program for calculating the geometrical characteristics of sections
- Parameters of compressible flow - an interactive program for parameters of compressible flow
- Calculation of the flow around a cone (example of solving a problem modeled by ODE) - computational problem solving, obtained results and analysis
- Simulation of plane take-off (also example of solving a problem modeled by ODE, application of interpolation methods to aerodynamic characteristics of aircrafts) - a program for calculating take-off distance and velocity
- FEM calculation of lattice structures (example of solving sparse systems of equations with many unknowns) - a program for calculating stresses of two-dimensional lattices
prerequisite

There are no necessary conditions for attending the subject.

learning resources

1. Petrovic Z, Stupar S, CFD one, Faculty of Mechanical Engineering, 1992, KPN
2. Additional materials (lecture hand-writings, problem settings, task solving guidelines), DVL
3. 452, Computer laboratory SimLab, IKT/CAH

number of hours

total number of hours: 45

active teaching (theoretical)

lectures: 15

active teaching (practical)

auditory exercises: 8
laboratory exercises: 0
calculation tasks: 6
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: 3
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): 60

references
Petrović Z, Stupar S, CFD one, Faculty of Mechanical Engineering, 1992, KPN
Cvetković, A., Radojević, S., Matlab 1, Mašinski fakultet, Beograd 2012.
Design and Technology of Airplane Manufacture

**ID:** MSc-1129  
**responsible/holder professor:** Grbović M. Aleksandar  
**teaching professor/s:** Grbović M. Aleksandar, Svorcan M. Jelena  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** aerospace engineering  
**semester.position:** 6.4

**goals**
To introduce students to process of airplane components modelling and help them to understand and apply technologies necessary for manufacturing of these components. Students are taught skills which connect typical aircraft loads with typical design solutions. Besides theoretical knowledge necessary to model aircraft, students will also learn basics of modern aircraft design software CATIA v5.

**learning outcomes**
Complete understanding of airplane structure and relationships among the elements. Understanding of aerodynamics, flight mechanics and propulsion group influences on aircraft design and ability to apply this knowledge to conceptual design of an aircraft. Understanding and specification of manufacturing process and surface protection. Mastering the modern software tools for design of aircraft assemblies and parts.

**theoretical teaching**

**practical teaching**
Practical exercises follow lectures illustrating them through applications. Students will learn how to use CATIA v5 design software. Students get skills within various modules of CATIA v5. Modelling of parts, sheet metal parts and drafting are covered. Students must design several aircraft parts using CATIA v5. Their works are presented to colleges. Discussion of strong and weak points of the design takes place during presentations.

**prerequisite**
As defined by curricula of study program.

**learning resources**
1. SimLab facility.
2. Software CATIA v5.

**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): 30

**references**

A. Grbovic, M. Milos: Software Tools in Design, Faculty of Mechanical Engineering, Belgrade, 2017

Handouts
FEM Analysis

ID: MSc-0544  
responsible/holder professor: Simonović M. Aleksandar  
teaching professor/s: Dinulović R. Mirko, Peković M. Ognjen, Svorcan M. Jelena, Simonović M. Aleksandar  
level of studies: B.Sc. (undergraduate) academic studies  
ECTS credits: 6  
final exam: written+oral  
parent department: aerospace engineering  
semester.position: 6.4

goals

Understanding and mastering the process of solving engineering problems using finite elements method and modern software tools. Furthermore, the aim of this course is to develop personal and professional skills of the students along with the development of analysis methodology and solving engineering problems.

learning outcomes

After accomplishing the course, a student is capable of working in modern work environments. With learned skills student can implement his theoretical and practical knowledge in engineering practice, achieving a high degree of effectiveness. This knowledge encourages further improvement for students.

theoretical teaching


practical teaching

Practice: mathematical foundations - numerical methods of analysis - the basics of matrix algebra - the mathematical interpretation of the finite element – solving engineering problems using FEM (linear elements) – solving engineering problems using FEM (surface elements) - solving engineering problems using FEM (volume elements) - a comparative analysis of the results obtained with finite element method and classical methods of calculation - the interpretation of results and verification of analysis results

prerequisite

Preferred: Attended and passed courses – Mathematics 1-3, Mechanics 1-3, Shape modeling, Strenght of material

learning resources

Faculty of Mechanical engineering — course catalog — B.Sc. (undergraduate) academic studies
455, Computer Lab – Design in mechanical engineering module
CATIA V5 software package, Computer Lab – Design in mechanical engineering module
Simlab - computer laboratory

**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**

M. Kalajdžić, "Finite Element Method ", IAMA Belgrade 1978., KDA(in Serbian)
Additional materials (written excerpts with the lectures, setting tasks, guidelines for solving the task), DVL
Fundamentals of aerotechnics

ID: MSc-0630

**responsible/holder professor:** Petrović B. Nebojša

**teaching professor/s:** Bengin Č. Aleksandar, Grbović M. Aleksandar, Dinulović R. Mirko, Mitrović B. Časlav, Petrović B. Nebojša, Fotev G. Vasko

**level of studies:** B.Sc. (undergraduate) academic studies

**ECTS credits:** 6

**final exam:** written

**parent department:** aerospace engineering

**semester.position:** 3.5

**goals**

The aim of this course is to introduce students to basic concepts in the field aerotechnics. The subject is presented in four integrated areas: aerodynamics, structures and construction, plant and equipment. In addition to popularize aviation, the aim of this course is to highlight the role of students in various fields aerotechnics mechanical engineering.

**learning outcomes**

After passing the subjects the students are expected to understand the basic concepts and problems in the field of aerodynamics, structures, construction, aircraft engines and aircraft equipment. In doing so, it is expected that the student able to recognize and apply these disciplines of aviation technology in other areas.

**theoretical teaching**

In the theoretical part analyzes the following topics: history of aviation, aircraft types (basic components and their role), the concept of aerodynamic forces, the notion of aerofoil (geometric and aerodynamic characteristics), different aerodynamic aircraft structural scheme: a mathematical model aircraft-core performance, analysis of mass, center of gravity, the notion Centraza; budget based aircraft structures, types of forces acting on the aircraft, the flight envelope, elementary calculations of aircraft parts (motor mount, nose leg); historical overview of aviation design, aviation design types, analysis of the construction costs of aviation; basic elements of stricture wings and fuselage, making Straka fuselage; types of facilities, historical development, basic concepts (traction and thrust force), piston-driven propeller, the impact position driveline, turbo-jet aircraft, rocket-powered aircraft; place and role equipment and systems, installation and basic aircraft systems, encoders, instruments and equipment (Historically the development of constructive solutions), role of computers in design, construction and maintenance.

**practical teaching**

In the practical part of teaching the short working computational tasks and analyze the concepts and examples of various constructive aerodynamic types solutions (different types of aircraft, vehicles, wind, etc.). Students operate using a virtual workshop on the internet in case they are registered in groups. Students, as part of their group, work of reference for a given aircraft, and the exercises are consulted about the form, scope and content of work. The paper presents representative of the group, in the last week of classes. Planned students excursions one of aviation organizations to familiar the real structures and systems used in aircraft.
prerequisite

without the conditions

learning resources

The work on the case is open a virtual shop on the Internet. MOODLE is used program. Students enrolling in the electronic workshop, a dress for the first time. In the workshop, students can access the professor notes, and additional material that advise the professor. As part of the work on subject is open a virtual workshop on the Internet. MOODLE is used program. Students be registered in the electronic workshop, and be trained for the first class. Using MOODLE students can access the professor notes, and additional material that advise the professor.

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: 0
seminar works: 0
project design: 40
final exam: 30
requirements to take the exam (number of points): 30
references
Introduction to engineering simulations

ID: MSc-0617  
**responsible/holder professor:** Bengin Č. Aleksandar  
**teaching professor/s:** Bengin Č. Aleksandar, Simonović M. Aleksandar  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** seminar works  
**parent department:** aerospace engineering  
**semester.position:** 5.4

**goals**

The students would be introduced to engineering simulations based on continuum mechanics. The students should acquire understanding of well posed problem through definition of boundary and initial conditions applied to certain physical phenomenon which characterize existence and uniqueness of the solution. Adoption of the specific type of additional conditions depending on the type of the problem, as well as selection of appropriate approximation for solution of the model problems would be presented to students. The students should gain skills for individual code development for model equations.

**learning outcomes**

By mastering the curriculum the student will gain sufficient theoretical knowledge necessary to identify the problem type, number and type of boundary conditions in order to define well posed problem which is simulated. The student will be able to identify basic schemes for calculation of problems of certain type. The basic principles of programming for simulation of continuum should be adopted by the student. The structure of simulation software which consist of preprocessing, simulation and visualization should be perceived by the student.

**theoretical teaching**

1. Introduction to engineering simulations in order to familiarize students with typical engineering problems 2. Fundamentals of numerical methods 3. Implementation of numerical methods for solving of engineering problems 4. Theoretical fundamentals for typical problems solving using complementary software tools

**practical teaching**

Exercises consist of three parts: introduction to work on Linux cluster, student registration and login and usage of commands for compilation, source code editing and visualization of the results. The second part of the exercises consist of practical demonstration of the methods presented in theoretical classes, where similar problems to problems for own student work are solved. The third component of the exercises is programming of the mentioned problems in order to complete the cycle of editing, compilation and result visualization process. The students are learned to present there work in general acceptable manner.

**prerequisite**

There aren’t any compulsory conditions for course attendance.
learning resources

1. Linux cluster

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): 35

references
Light and Composite Structures

ID: MSc-1077
responsible/holder professor: Peković M. Ognjen
teaching professor/s: Dinulović R. Mirko, Peković M. Ognjen, Svorcan M. Jelena, Simonović M. Aleksandar
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: oral
parent department: aerospace engineering
semester.position: 6.4

goals

The goal of the course is to acquaint students with the properties of composite materials used for making aircraft structures, composite manufacturing technologies as well as the specifics of their implementation and exploitation in aeronautics.

learning outcomes

After completing the course, a student is familiar with the philosophy of design, manufacturing technologies and specifics of protection, exploitation and maintenance of composite aircraft structures. Acquired theoretical knowledge and practical skills, students can effectively apply in the construction of composite aircraft parts and their analysis. Within practical training students learn the basics of modern software packages intended for the modeling and calculation of composite parts.

theoretical teaching

- Overview of composite materials application in military and civil aviation
- Mechanics of Composite Materials
- Design of composite parts
- Production of composite parts - the integration of production processes and CAD
- Machining of composite structures; joining of composite parts.
- Damage of composite structures; classification of damage and methods of repairs
- Testing and certification of composite structures
- Trends and future applications of composite structures. New technologies of production.

practical teaching

Within lab exercises, the material exposed during theoretical lectures is expanded with concrete examples. Students gain experience in the use of modern engineering software, with an emphasis on shape modeling, material properties modeling and finite element analysis, which they can later use for solving real engineering problems.

prerequisite

No obligatory prerequisites.
Suggested attended and passed courses: Mechanics 1-3, Strength of materials
learning resources

1. Lecture materials (written excerpts of the lectures, problem formulations, guidelines for solving the problems), DVL

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: 0
project design: 10
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: 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
Mechanics of Flight

ID: MSc-0944  
responsible/holder professor: Mitrović B. Časlav  
teaching professor/s: Bengin Č. Aleksandar, Mitrović B. Časlav  
level of studies: B.Sc. (undergraduate) academic studies  
ECTS credits: 6  
final exam: project design  
parent department: aerospace engineering  
semester.position: 5.4

goals

The main objective of the course is to develop understanding of the mechanics of aircraft flight. Methods to assess and calculate the basic performance, stability, controlling and maneuverability of aircraft will be studied in the course.

learning outcomes

Having mastered the planned curriculum, the student acquires sufficient theoretical and practical knowledge to be able to estimate independently the performance possibilities 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.
- General definitions of flight mechanics.
- General characteristics of the power plant.
- Stationary flight condition aircraft performance.
- Special performances: takeoff, landing, range and flight duration.
- Horizontal flight.
- Powerless flight.
- Acrobatic flight maneuvers:
  * dive,
  * loop (looping),
  * combat turn,
  * inverted flying,
  * "knife-edge" maneuver,
  * Cuban eight,
  * turns, roll,
  * "Bell" maneuver,
  * "Cobra" maneuver,
  * Immelman turn,
  * stall and
  * spin.
- Fundamentals of stability and maneuverability of the aircraft.
- Fundamentals of flight tests.

practical teaching

Revision of aero properties of the atmosphere. International standard atmosphere.
Measurement of the basic parameters of airflow in the wind tunnel. Measurement of basic parameters of the load model in the wind tunnel. Project assignment on the aircraft performance. Tutorials follow the theoretical lectures.

**prerequisite**

No special conditions.

**learning resources**

Basic material: Č. Mitrović – Mechanics of Flight (handouts) and instructions for project assignment (handouts).
Additional material: 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: 0
laboratory exercises: 10
calculation tasks: 0
seminar works: 5
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: 5
check and assessment of seminar works: 0
check and assessment of projects: 5
colloquium, with assessment: 0
test, with assessment: 5
final exam: 0

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

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

references

Basic material: Č. Mitrović – Mechanics of Flight (handouts) and instructions for project assignment (handouts).
Z. Rendulić, Flight mechanics, Belgrade, VINC 1987
D.G. Hull, Fundamentals of Airplane Flight Mechanics, Springer
OXFORD: Book 6 - Flight Performance & Planning 1, Book 7 - Flight Performance & Planning 2, Book 13 - Principles of Flight
D.Cvetković, Flight mechanics - performance aircraft, Own edition, 2004
Skill Praxis B - VAZ

ID: MSc-1215  
**responsible/holder professor:** Petrović B. Nebojša  
**teaching professor/s:** Dinulović R. Mirko, Petrović B. Nebojša  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 1  
**final exam:** written  
**parent department:** aerospace engineering  
**semester.position:** 4.5  

**goals**

The goal of this course is to introduce students to the process of design and construction of aircraft technology, installation of aviation equipment and systems, process manufacturing aircraft components, methods of aircraft ground and flight testing; introduction to the factories technological production lines, quality control, safety systems organization, maintenance process.

**learning outcomes**

Successful completion of this course students are introduced to: corresponding types of aircraft, analysis methods and procedures of design and construction of aircraft, aircraft technical regulations of safety and maintenance (JAR i FAR) etc.

**theoretical teaching**

Introduction. The role and importance of professional practice in the education of engineers of aviation. The basic principles of design and construction of aircraft; aerodynamics, design, structure, aircraft equipment, systems and propulsion. Basic methods of aircraft testing. Measuring and testing equipment. Safety and aircraft maintenance. Instructions for keeping a diary.

**practical teaching**

Tours and visits to factories • project organizations in the field of aviation, • organizations that produce components and equipment in the field of aviation • maintenance organizations, organizations involved in testing • organizations involved in the organization of air traffic, organizations involved in education of aviation personnel, visits to aviation meetings. In an independent work, students completing the practice technical report.

**prerequisite**

There are no attendance requirements for professional practice.

**learning resources**

**number of hours**

total number of hours: 90

**active teaching (theoretical)**

lectures: 0
active teaching (practical)

auditory exercises: 20
laboratory exercises: 60
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: 5
colloquium, with assessment: 0
test, with assessment: 0
final exam: 5

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): 0

references
Structural Analysis of Flying Vehicles

ID: MSc-0945
responsible/holder professor: Petrašinović M. Danilo
teaching professor/s: Grbović M. Aleksandar, Dinulović R. Mirko, Petrašinović M. Danilo
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written
parent department: aerospace engineering
semester.position: 6.3

goals

1. Introduction to problems and modern solution methods in stress analysis related to aircraft structures and their implementation in solving real structural problems.
2. Introduction to experimental stress analysis of aircraft structures.
3. Introduction to thin-walled structures and composite materials.
4. Introduction to computer modeling and simulation of aircraft structures.

learning outcomes

1. Mastering basic theoretical knowledge in structural analysis.
2. Application of acquired knowledge in solving real life problems.
3. Understanding the basic aircraft design principles.
4. Understanding the modern approach in solving structural problems in aircraft airframe design.

theoretical teaching

In the theoretical part the following topics are covered: aircraft loads, load coefficient, flight envelope, flight envelope for symmetric flight cases, gust loads, unsymmetrical loading conditions, landing gear loads, engine mount loads and stress analysis, wing skin, sing skin buckling, normal and shear stress calculation, effective width, wing stress analysis, wing spar analysis, wing-fuselage rib connection analysis, design solutions, delta wing stress calculation, fuselage stress strain calculation methods, pressurized cabin calculation, stress analysis in the vicinity of openings, fuselage rib calculation, finite element method applied to airframe structural analysis, structure idealization, composite material stress calculation, static and dynamic testing and testing equipment design, apparatus and techniques in experimental stress analysis.

practical teaching

During the practical part of the course theories related to aircraft stress analysis are applied to real problems. Numerical examples are analyzed. Practical student work is realized through mandatory exercises and design project realization using computer software for modeling and analysis. Professor lecture notes, solved past exam papers are at student’s disposition. Practical part of the course also includes visit to the VTI technical institute.

prerequisite

no special requirements

learning resources
Lecture notes in e-format, media films and computer simulation models, 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: 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**

Structural and Stress analysis, T.H.G Megson
Structural Analysis, Hibbeler Russell C.
Theory of Elasticity

**ID:** MSc-0539  
**responsible/holder professor:** Dinulović R. Mirko  
**teaching professor/s:** Dinulović R. Mirko, Simonović M. Aleksandar  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** aerospace engineering  
**semester.position:** 5.5

**goals**

1. Introduction to stress analysis related to aircraft structures and it's application to practical airframe sizing and stress analysis.  
2. Introduction to Experimental stress-strain analysis of airframe structures  
3. Introduction to thin-walled constructions and composite material constructions  
4. Introduction to modern numerical stress analysis applied to aircraft constructions, analysis and performance

**learning outcomes**

In the end of the course, students should be able to:

1. Calculate the stress-strain state of thin-walled metallic structure in the linear domain for a preset load.  
2. On the basis of a calculated stress strain state, dimension main parts of aircraft structure such as wing skins, spar webs, spar caps, wing ribs, fuselage frame and stringers.  
3. To effectively use commercial software for structural analysis based on finite element method.  
4. Generate finite element models of parts of aircraft structures and perform structural analysis

**theoretical teaching**


**practical teaching**

During practical part of the course covered topics in theoretical part are demonstrated in practice. Typical practical problems 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: 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): 21

references
Structural and Stress analysis, T.H.G Megson
Elasticity, Chou and Pagano
Windturbines

ID: MSc-1075
responsible/holder professor: Simonović M. Aleksandar
teaching professor/s: Peković M. Ognjen, Svorcan M. Jelena, Simonović M. Aleksandar
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: oral
parent department: aerospace engineering
semester.position: 5.5

goals

Throughout this course student will learn about the principles, components and design of wind turbines, as well as regulation and dynamic balancing of the system. Acquiring the knowledge necessary for wind turbine blade design based on the aerodynamic and structural criteria, performance computation (power, coefficient of power, torque, aerodynamic characteristics of blades), calculation based on similarity theory and the topology definition of wind energy systems is the main aim of the subject.

learning outcomes

Mastering the curriculum the student receives the following subject-specific skills:

- thorough knowledge and understanding of different concepts of wind turbines and design methods;
- skills needed for wind turbine and its parts selection according to given operating conditions using scientific methods and procedures;
- integration of fundamental knowledge in mathematics, programming, mechanics and fluid mechanics and application to design and calculations of wind turbines;

theoretical teaching

- Introduction to wind energy; - Historical overview of wind turbines;
- Components of wind turbines – analysis and design of rudimentary assemblies;
- Wind characteristics
- Dimensioning of wind turbine blades – Betz theory, aerodynamic forces on rotating blades, the losses;
- Calculation of characteristics;
- Structure and blade load;
- wind turbines similarity theory- application and limitations;
- pumps driven by wind- possibilities of application, types, coupling of wind turbines and pumps, sizing;
- wind turbine electrical system- main concepts, types of generators, accumulation of electrical energy, systems connected to public grid, losses in energy transmission system;
- Regulation of wind turbines;
- The dynamics of wind turbines - the oscillations in the system, modeling of oscillations;
- Off-shore wind turbines - requirements, types of off-shore wind turbines, foundations and structure of the types of off-shore wind farms, maintenance
- The construction of wind turbines

practical teaching
- Presentation of various wind turbine designs
- Basic parts of the system
- Devices for the wind speed measurements - anemometers
- Dimensioning of the blades - a numerical simulation of the flow around airfoils and blades
dimensioning
- Performance calculations - the development and application of existing software for the
calculation of characteristics of wind turbines
- Analysis of the stress - strain state of turbine rotor blades
- Static testing of blades
- Dynamic testing of blades
- Configuration of wind energy systems

prerequisite

There are not any compulsory conditions for course attendance.

learning resources

1. Pesic S., Wind energy - Aerodynamics wind energy system with a horizontal axis rotor,
   Faculty of Mechanical Engineering, 1994., KDA(in serbian)
2. Petrović Ž. Stupar S., Computer design, Faculty of Mechanical Engineering, 1992, KPN(in
   serbian)
3. Additional materials (written performed with the lectures, setting tasks, guidelines for
   solving the task), DVL
4. 452, Computer Laboratory SimLab, ICT / CAH / KLR
5. FORTRAN, Computer Laboratory SimLab, ICT / PPO

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: 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: 4
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: 15
laboratory exercises: 15
calculation tasks: 15
seminar works: 15
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**

1. Pesic S., Wind energy - Aerodynamics wind energy system with a horizontal axis rotor, Faculty of Mechanical Engineering, 1994., KDA(in serbian)
Automation Systems Programming

ID: MSc-0590

responsible/holder professor: Jovanović Ž. Radiša

Teaching professor/s: Jovanović Ž. Radiša, Ristanović R. Milan

level of studies: B.Sc. (undergraduate) academic studies

ECTS credits: 6

final exam: written

parent department: control engineering

semester.position: 5.4

goals

• Introduction to the basic applications of digital computers in automatic control.
• Candidate will be familiar with the basic statements of programming package MATLAB.
• Candidate will be familiar with the application of programming packages MATLAB and Simulink in modeling and simulation of dynamical systems.

learning outcomes

• Acquiring basic knowledge in programming tools MATLAB and Simulink.
• Introducing and using methods for modeling, analysis and synthesis of control systems by mentioned programming.

theoretical teaching


practical teaching

PL:
Practical examples that follow the content of course. Application of PC computer as digital controller. Modeling and simulation of various objects of automatic control 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 control plants (DC servo motor, inverted pendulum, double inverted pendulum, heat flow experiment, coupled water tanks experiment), with acquisition hardware and software,
- Automatic Control Laboratory, Intelligent Control Systems Laboratory.

designation 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): 30

references
Computer Control Systems

ID: MSc-0581  
**responsible/holder professor:** Ribar B. Zoran  
**teaching professor/s:** Jovanović Ž. Radiša, Ribar B. Zoran  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** control engineering  
**semester.position:** 3.5

**goals**

- This subject introduce candidate with basic principles of computer control systems. Also the candidate will be qualified to implement and verify presented theory to real computer control systems.  
- Candidate will be familiar with some metodologies for selecting components of various computer control systema.  
- Candidate will be familiar with real systems functionality as well as tuning of computer control systems.

**learning outcomes**

- Introduction with basic principles of computer control systems that is necessary to modern engineer.  
- Introduction and use of various methods for control control systems analysis and synthesis.  
- Development of analythical and/or experimental methods of testing basic dynamic and static characteristics of control components and computer control systems.

**theoretical teaching**


**practical teaching**


- Practice with PLC. Example of SCADA system. Practice with Matlab/Simulink. Practice with
potentiometric motion transducers. Transducers power supplies. Indication instruments.
Practice with pressure transducers. Calibration and tuning.
Electric motors and frequency converters. Hydraulic cylinder with spool valve. Statical
characteristics determination.

**prerequisite**

Basic principles of thermodynamics, fluid mechanics and physics.

**learning resources**

- Computer control electrohydraulic servosystem, Control systems laboratory.
- Computer control electropneumatic servosystem, Control systems laboratory.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 22
laboratory exercises: 8
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

Digital systems

ID: MSc-0595

responsible/holder professor: Bučevac M. Zoran

Teaching professor/s: Bučevac M. Zoran, Jovanović Ž. Radiša

level of studies: B.Sc. (undergraduate) academic studies

ECTS credits: 6

final exam: written

Parent department: control engineering

semester.position: 5.5

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

• Proper understanding of the nature of digital computers and processes inside them.
• Manipulating digital computers in hardware and software sense as a part of a digital control systems (DCS).
• Using the methods of analysis and synthesis of LC.
• Solving of computational nature problems related to the analysis and synthesis of LC, in "off line" mode, by means of digital computers.
• 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): 30

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
Fundamentals of Clinical Engineering

ID: MSc-0815  
**responsible/holder professor:** Matija R. Lidija  
**teaching professor/s:** Matija R. Lidija  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 2  
**final exam:** written  
**parent department:** control engineering  
**semester.position:** 5.5

**goals**

Introduction to clinical engineering based on examples (high-quality application of medical technologies and information technologies, quality assurance, implementation of "good medical practice" etc.). Introduction to medical technologies which heavily rely on clinical engineers (i.e. medical imaging, radiation protection, rehabilitation, use of robots, etc.). General introduction to medical equipment. Basics of medical equipment design and maintenance (surgical tables, beds, chairs, etc.). Introduction to medical device maintenance. Introduction to legislation regarding medical device design and maintenance. Maintenance of concrete devices. Basics of medical device maintenance.

**learning outcomes**

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

- To adopt and differentiate operating principles in a clinical setting (ethics, standards, information technology)
- To describe the main characteristics and design of the medical devices and define their appropriate applications
- To master the design process of medical devices, from the initial idea to the final realization, and manage project planning, project flow and project budget

**theoretical teaching**

practical teaching

Application of gamma camera and PET (at the Clinical Center of Serbia). Ultrasound applications in medicine (at the MMA). Measurement of temperature distribution (in the laboratory).
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".

prerequisite

Requirements for attending are defined with curriculum of study program/module.

learning resources

1. Written course material (handouts).
2. Printed manuals.
3. Thermographic camera.

number of hours

total number of hours: 30

active teaching (theoretical)

lectures: 10

active teaching (practical)

auditory exercises: 0
laboratory exercises: 8
calculation tasks: 0
seminar works: 0
project design: 3
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: 3
colloquium, with assessment: 0
test, with assessment: 2
final exam: 1

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

Fundamentals of Control Engineering

**ID:** MSc-0041  
**responsible/holder professor:** Lazić V. Dragan  
**teaching professor/s:** Bučevac M. Zoran, Jovanović Ž. Radiša, Lazić V. Dragan, Ribar B. Zoran, Ribar N. Srđan, Ristanović R. Milan  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** control engineering  
**semester.position:** 6.2

**goals**

Introduction to basic concepts in the field of Automatic Control and training for implementation and verification of acquired knowledge to specific physical systems and processes.

Acceptance of some methodologies for analytical and experimental verification of the basic static and dynamic characteristics and parameters of the system.

Learning basic MATLAB tools to help in calculation and simulation of all of the computational parts of this subject.

**learning outcomes**

Getting basic knowledge of the automatic control.

Identify and use the methods needed for analysis and synthesis of the controllers as a part of the control system, as well as the whole automatic control system.

For proper use of computers and MATLAB in solving the main problems of the control systems, as well as other engineering problems.

To be analytical and / or experimentally investigated the basic dynamic and static characteristics of the system

**theoretical teaching**

Introduction to basic concepts and terms in the field of the automatic control. Basic concepts of the automatic control. The control systems of basic physical values (position, level, pressure, flow, temperature, speed, ...) illustrated the most frequent objects and processes in mechanical engineering. The basic dynamic and static characteristics and parameters of the system in time domain, their analytical determination (time constant, rise time, settling time, overshoot, gain, static error, ...). The transfer function of the system. Block diagrams. Frequency response of the system. The main indicators of the system in the domain of frequency response (resonance frequency, attenuation, bandwidth, ...). The basic types of control systems: P, PI, PID and their impact on the dynamic and static properties of the system through the commonly used objects and processes in mechanical engineering. The concept of stability criterion for the stability checking of linear systems.

**practical teaching**

Practical training shall include all the above experimental methods, and training is based on simulation using MATLAB.

Presentation of the systems and physical values by the standard symbols, labels and understanding of control principles based on design documentation.

Experimental evaluation of the main system parameters in the time domain (time constant,
rise time, settling time, overshoot, gain, static error, ...).
The transfer function, experimental determination and significance.
Frequency response of the system, the experimental determination and significance.
Hydraulic servo systems, servo valves, hydraulic cylinders.

**prerequisite**

Basic computer knowledge founded on PCs platforms, basic knowledge of higher education mathematics.

**learning resources**

- Literature on the website http://au.mas.bg.ac.rs/el - Moodle
- Licensed Software in the possession of faculties.
- Freeware software.
- PCs.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

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

**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: 8
test, with assessment: 2
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): 20

references

Ljubomir Grujic, Dragan Lazic, "INTRODUCTION TO AUTOMATIC CONTROL", Script, Faculty of Mechanical Eng., 2007
Dragan V. Lazic, Milan R. Ristanovic, "INTRODUCTION TO AUTOMATIC CONTROL", Faculty of Mechanical Eng., 2005
Measurement in control systems

**ID:** MSc-0931  
**responsible/holder professor:** Ribar B. Zoran  
**teaching professor/s:** Jovanović Ž. Radiša, Ribar B. Zoran  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** control engineering  
**semester.position:** 6.3  

**goals**

Automatic control systems consist of one or more measurement systems. Proper functionality of these systems are of most importance for good characteristics of automatic control systems. So students must be introduced in various types of measurement of physical values. Also statical and dynamic characteristics of measurement systems are of great importance. Finaly basic physical principles of sensing elements will be presented.

**learning outcomes**

Basic physical principles are necessary for study of sensor elements. Also basic principles of electric engineering and electroniscs is necessary. Knowledge of automatic control and Digital systems is of great importance.

**theoretical teaching**

Measuring systems. Structural diagram of measurement systems. Measurement systems and automatic control systems.  
Types of sensor elements. resistive elements. Capacitive sensors. Inductive sensurs.  
Signal processing elements. Counters in measurement systems. Analog to digital converters in measurement systems. Microprocessor systems.  
Data presentation systems. Pointer scale indicators. Recorders. Alphanumeric displays. LC displays. LED displays.

**practical teaching**

Practice with displacement transmitters. Potentiometers. Inductive displacement transducers.  
Practice with pressure sensors. Temperature measurement with resistive Pt100 transducers.  

**prerequisite**

Necessary of Physics and Mathematics 1 and 2 knowledge.

**learning resources**

Liquid level measurement installation.
Temperature measurement installation.
Angular speed, position and electric current of DC motor measurement installation.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 22
laboratory exercises: 8
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**

Pneumoelectric control systema Z. Ribar Faculty of Mechanical Engineering Belgrade 1997.
Hands-out Measurement in Control Systems
Biomaterials foundations

**ID:** MSc-0970  
**responsible/holder professor:** Sedmak S. Aleksandar  
**teaching professor/s:** Sedmak S. Aleksandar  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** engineering materials and welding, tribology, fuels and combustion  
**semester.position:** 5.5

**goals**

The aim of this course is to introduce students to different types of biomaterials and their properties with the goal of understanding and studying the possibility of using biomaterials in human organism. Special attention is devoted to the appearance of damage and failure of biomaterials which are in contact with or are within human body, as well as consequences due to these processes. This course enables possible collaborations between experts in the fields of material science and medicine, more particularly it enables work with specialized clinics and laboratories that conduct research and engineering of biomaterials.

**learning outcomes**

Attending this course student will develop abilities of all encompassing analysis of the problem of the contact between the artificial biomaterial and living organism, and the potential to predict optimal choice of biomaterial using scientific methods as well as present-day lab equipment. Due to this course a student will also develop the ability to combine knowledge from different areas of material science, biology, physics, mechanics and physiology together with learned biomedical engineering.

**theoretical teaching**

Basic types of biomaterials and comparison of their physical, chemical and mechanical properties. Biocompatibility. Metal biomaterials, their advantages and disadvantages. Application of metal biomaterials in medicine and stomatology. Ceramic biomaterials, types, structure and properties. Ceramic biomaterials in medicine and stomatology. Polymer based biomaterial, artificial and natural, production process, structure, types and properties. Sterilization. Composite biomaterials, types, structure and properties.

**practical teaching**


**prerequisite**

Faculty of Mechanical engineering — course catalog — B.Sc. (undergraduate) academic studies
Necessary conditions: Engineering materials 1 and 2. Desired conditions: The introduction to biomedical engineering, Human Anatomy and Physiology.

**learning resources**

5. V.V. Vasiliev, E.V. Morozov, Mechanics and analysis of composite materials, 2001 Elsevier, KCJ

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 2
calculation tasks: 10
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: 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: 10
test/colloquium: 25
laboratory exercises: 5
calculation tasks: 5
seminar works: 25
project design: 0
final exam: 30
requirements to take the exam (number of points): 35
references

J. Lemons, Ceramics: Past, present, future, Bone 19 No1(1996) 121S-128S
Combustion and sustainable development B

**ID:** MSc-1034  
**responsible/holder professor:** Milivojević M. Aleksandar  
**teaching professor/s:** Milivojević M. Aleksandar  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** engineering materials and welding, tribology, fuels and combustion  
**semester.position:** 6.4

**goals**

In light of the fact that currently over 90% of world energy demand is satisfied by combustion processes, and that in the coming decades is projected that combustion will be the predominant technology, with a share of over 65%, this course is designed, keeping in mind the main goal is to introduce students in the area of the problems of sustainable development and energy, to provide better understanding, accept the findings and enable it to competently participate in its resolution.

**learning outcomes**

After completion of this course students should be able to:
- overview of the current and future challenges posed by the new scenario of the problem of energy efficiency and sustainable development,
- use and apply combustion technology in existing and future energy systems and technologies,
- apply 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 processes.  
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: 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: 10
calculation tasks: 0
seminar works: 20
project design: 0
final exam: 30
requirements to take the exam (number of points): 30
references

Principles of Combustion (Принципи сагоревања), Kenneth K. Kuo, BARNES & NOBLE
Combustion B

ID: MSc-0968
responsible/holder professor: Jovanović V. Vladimir
teaching professor/s: Jovanović V. Vladimir, Manić G. Nebojša, Stojiljković D. Dragoslava
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: oral
parent department: engineering materials and welding, tribology, fuels and combustion
semester.position: 5.4

goals

Fundamentals of thermodynamics of the combustion process, general terms, material and
energy balance of the process. Fundamentals of chemical statics and kinetics of thermal
processes. Physical and physical-chemical phenomena in the combustion process.
Environmental aspects of combustion.

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 type
   according to the adopted criteria.
2 Calculation of the amount of the combustion products, their composition and the to
   calculate combustion temperature.
3 Perform the material and energy balance of the combustion process.
4 Define the basic concepts for the characterization of flame, the criteria for the flame
   characterization and the flame types according to the adopted criteria.
5 Determine the basic characteristics of the fuel in laboratory conditions: moisture content,
   mineral content, volatiles content, carbon residue content, heating value.
6 Determine the basic flame characteristics in the laboratory: laminar flame length, stable
   combustion limits, the ignition limits of and linear flame speed.

theoretical teaching

Fuel and combustion basics. The quantity and composition of combustion products.
Combustion temperature. Fundamentals of thermodynamics of the combustion process,
general terms, material and energy balance processes. Fundamentals of chemical statics
and kinetics of thermal processes. Chemical equilibrium, the speed of chemical reactions.
Physical and physical-chemical phenomena in the combustion process. Specific features of
combustion of solid, liquid and gaseous fuels. Environmental aspects of combustion. The
causes, mechanisms of toxic components and the possibilities for prevention.

practical teaching

Determining the characteristics of proximate analysis of solid fuels. Determination of the
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. Dissociation products of
combustion. Determination of the dissociation temperature of combustion. Incomplete
combustion. Length of the laminar flame. The boundaries of stable combustion. Ignition
limits (concentrations). Flame front
propagation speed.

**prerequisite**

No special requirements for attendance the course.

**learning resources**

**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**
Engineering Materials 1

ID: MSc-0883
responsible/holder professor: Radaković J. Zoran
teaching professor/s: Bakić M. Gordana, Đukić Z. Miloš, Popović D. Olivera, Prokić-Cvetković M. Radica, Radaković J. Zoran
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 2
final exam: written+oral
parent department: engineering materials and welding, tribology, fuels and combustion
semester.position: 2.4

goals

After successfully attending the course, consisting of theoretical lectures on Engineering Materials 1, as well as maximal commitment in the practical topics of the course (through laboratory and problem solving exercises), the students become competent in the fundamentals of engineering materials, thus acquiring certain academic skills. By developing creativity and mastering specific skills that are necessary in the field of mechanical engineering, students understand the structure of materials, their properties, applications and the possibilities for processing and altering their chemical, physical and technological properties.

learning outcomes

Upon the successful completion of the course, the students are able to:

• Identify the type of chemical bonding, crystal structure, and properties for a given type of material (metal, ceramic, polymer)
• Apply information on elastic and plastic deformation for predicting the loads or strain, that lead to yielding, ultimate strength, or fracture. Differentiate the characteristic stress–deformation in metals, ceramics, crystals and non-crystals, polymers
• Identify common defects in materials, when do they occur, and how they influence the mechanical characteristics of materials
• Recognize the mechanisms that alter the mechanical properties of materials (deformation hardening, solid solution and precipitation hardening, …)
• Identify phases and concentrations, eutectic, eutectoid alloys and reactions on phase diagrams of solid state components – with complete and partial solubility, and components with the absence of solubility, and recognize simple microstructures and their influence on mechanical properties of materials
• Perform experiments (standard destructive tests) from which they analyze and interpret results of mechanical tests (hardness, plasticity, toughness, material resistance and deformation) on standard devices and machines (devices for measuring hardness by static and dynamic load, tensile testing machines, Charpy pendulum, extensometers, …)
• Select the material type for the given system, component or process, as to satisfy the loading and functionality criteria, from the aspects of the structure, property, technology and process
• Recognize the types of damage in engineering materials, their application and behaviour in exploitation (fatigue and creep), the classification and specifics of certain groups of modern materials used in mechanical engineering applications
• Apply the concepts of crack propagation and brittle fracture, as well as the ductile-to-brittle transitional effects in the goal to predict the fracture of brittle materials
theoretical teaching


practical teaching


prerequisite

Basic knowledge of mathematics, physics and chemistry.

learning resources

1. Prokić-Cvetković, R., Popović, O.: Engineering Materials 1, University of Belgrade, Faculty of Mechanical Engineering, 2012. (in Serbian)
2. Lecture handouts, documents to download from the web at http://afrodita.rcub.bg.ac.rs/~rzoran (in Serbian)
6. Šiđanin, L.: Engineering Materials 2, University of Novi Sad, Faculty of Technical Sciences, 1996. (in Serbian)

number of hours

total number of hours: 30

active teaching (theoretical)
lectures: 15

**active teaching (practical)**

auditory exercises: 4
laboratory exercises: 4
calculation tasks: 1
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: 1
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 2
test, with assessment: 0
final exam: 2

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

feedback during course study: 5
test/colloquium: 15
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 70
requirements to take the exam (number of points): 30

**references**

Прокић-Цветковић, Р., Поповић, О.: Машински материјали 1, издање Машинског факултета Универзитета у Београду, 2012.
Прокић-Цветковић, Р., Поповић, О.: Машински материјали 1, издање Машинског факултета Универзитета у Београду, 2012.
Шићанин, Л.: Машински материјали 2, ФТН, Нови Сад, 1996.
**Engineering materials 2**

**ID:** MSc-0884  
**responsible/holder professor:** Prokić-Cvetković M. Radica  
**teaching professor/s:** Bakić M. Gordana, Đukić Z. Miloš, Popović D. Olivera, Prokić-Cvetković M. Radica, Radaković J. Zoran  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** engineering materials and welding, tribology, fuels and combustion  
**semester.position:** 3.4

**goals**

The aim of this course is for students to become competent in the area of Engineering materials 2. They should also develop appropriate academic skills and creativity and master practical skills needed for the profession. This course is designed to provide information through theoretical lectures but also through laboratory type (practical) exercises, computational classes and seminar papers students are responsible for writing.

**learning outcomes**

Upon the successful completion of the course, the students are able to:

- Understand the dependence between microstructure, Fe-Fe₃C and Fe-C phase diagrams, and the mechanical properties of the material
- Differentiate between steels and irons and define the fields of their application
- Select the proper heat- or chemical treatment, based on the required properties of the steel
- Define the characteristics and application of light and non-ferrous metals and alloys (Al, Cu, Ni, Ti, ...)

- Understand the conventional welding techniques
- Differentiate between the conventional welding techniques
- Apply the proper welding procedure for the given material

**theoretical teaching**


**practical teaching**

Technics and technologies of oxifuel welding and cutting. Resistance welding and methods. Welding Laboratory practice - electric arc welding, oxyfuel welding and cutting, resistance welding. Tests and Office hours.

**prerequisite**

Necessary conditions for a student to attend this course are: attended course lectures and finished exercises of Engineering materials 1.

**learning resources**

2. V. Đorđević, Mašinski materijali, Mašinski fakultet, Beograd, 1999

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 20

**active teaching (practical)**

auditory exercises: 14
laboratory exercises: 24
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: 4
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: 30
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 40
references

Fuel, Lubricants and Industrial Water

ID: MSc-0054

responsible/holder professor: Stojilković D. Dragoslava

Teaching professor/s: Jovanović V. Vladimir, Manić G. Nebojša, Stojilković D. Dragoslava

level of studies: B.Sc. (undergraduate) academic studies

ECTS credits: 6

final exam: oral

parent department: engineering materials and welding, tribology, fuels and combustion

semester.position: 3.5

goals


learning outcomes

Acquisition of basic knowledge about the concept of fuel, types and properties. Mastering the basic techniques of calculation of quantity and composition of the products of combustion and combustion temperature. Acquiring basic knowledge on the characterization of solid fuels, their origins, derivation and application. Basic knowledge of liquid and gaseous fuels, their origins, derivation and application. Basic knowledge about the types of lubricants, properties and application. Basic knowledge about water and preparation for use in industrial purposes.

theoretical teaching


practical teaching


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: 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
**Skill Praxis B - ZZK**

**ID:** MSc-1229  
**responsible/holder professor:** Sedmak S. Aleksandar  
**teaching professor/s:** Sedmak S. Aleksandar  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 1  
**final exam:** seminar works  
**parent department:** engineering materials and welding, tribology, fuels and combustion  
**semester.position:** 4.5

**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: 5
laboratory exercises: 5
calculation tasks: 0
seminar works: 10
project design: 0
consultations: 20
discussion and workshop: 25
research: 0

**knowledge checks**

check and assessment of calculation tasks: 0
check and assessment of lab reports: 1
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: 5
test/colloquium: 0
laboratory exercises: 5
calculation tasks: 0
seminar works: 60
project design: 0
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
Tribology

ID: MSc-0517
responsible/holder professor: Venc̆ A. Aleksandar
teaching professor/s: Venc̆ A. Aleksandar
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: oral
parent department: engineering materials and welding, tribology, fuels and combustion
semester.position: 5.4

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

Tribochnique

**ID:** MSc-0371  
**responsible/holder professor:** Vencl A. Aleksandar  
**teaching professor/s:** Vencl A. Aleksandar  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** engineering materials and welding, tribology, fuels and combustion  
**semester.position:** 6.4

**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 tribochnique 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 tribochnique 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 tribochnique.
- 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 potentional 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**

Fluid mechanics B

ID: MSc-0684  
responsible/holder professor: Crnojević Đ. Cvetko  
teaching professor/s: Lečić R. Milan, Milićev S. Snežana, Stevanović D. Nevena, Ćoćić S. Aleksandar, Crnojević Đ. Cvetko  
level of studies: B.Sc. (undergraduate) academic studies  
ECTS credits: 6  
final exam: written+oral  
parent department: fluid mechanics  
semester.position: 5.1

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. Also another important goal of the subject is the teach the student the basics of experimental methods in fluid mechanics. This will be accomplished by the work in the laboratory.

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

To the listener student third year of study.

learning resources

Some chapters from books written by professors from the Chair, Handouts, and laboratory equipment.

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
Hydraulics and pneumatics

ID: MSc-0347  
responsible/holder professor: Lečić R. Milan  
teaching professor/s: Lečić R. Milan, Ćoćić S. Aleksandar, Crnojević Đ. Cvetko  
level of studies: B.Sc. (undergraduate) academic studies  
ECTS credits: 6  
final exam: written+oral  
parent department: fluid mechanics  
semester.position: 6.3

goals

This course aims to teach students basic knowledge of hydraulics and pneumatics. First of all they need to learn to read schemes of hydraulic oil and pneumatic systems. In addition to this the audience of this course should be familiar with basic elements of all systems, with their functionality, place and role in hydraulic oil and pneumatic systems. Besides this, the aim of this course is to teach listeners the basics of calculations of elements, circuits and systems in general.

learning outcomes

The students listened to and passed this course will be able to read correctly each scheme of oil hydraulic or pneumatic system. In addition to understanding the scheme they will be able to accurately determine functionality of given system. Also, they will be able to independently calculate existing oil hydraulics and pneumatics systems in stationary regimes. Students will be able to select appropriate components of hydraulic or pneumatic system for specific tasks of power transmission and connect them in functional way.

theoretical teaching


practical teaching

pressure differential device and through pressure differential devices connected in series.

**prerequisite**

Passed examination of Fluid Mechanics B.

**learning resources**

Manuscript of lectures. Oil hydraulic components with section. Pneumatic installation for demonstration. Facility for testing the hydraulic characteristic of distributor.

**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: 0
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 6
test, with assessment: 4
final exam: 5

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

feedback during course study: 10
test/colloquium: 10
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 70
requirements to take the exam (number of points): 20

**references**
Crnojevic C., Classical and oil hydraulic, Faculty of Mechanical Engineering University of Belgrade, 2006
Fundamentals of Technical Innovation

ID: MSc-1092
responsible/holder professor: Miloš V. Marko
teaching professor/s: Miloš V. Marko
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: oral
parent department: general machine design
semester.position: 5.4

goals

Explain to the students that technical innovations are basis of economic development of society. The development of science, technology and social awareness suppresses the existing technical solutions and imposes the need for new developments. To introduce students to the concept of technical innovation, with the methodology of development of new technical systems that are essentially different from the existing ones, which represents a transformation of the achieved level of knowledge in technical solutions. The aim of this course is to introduce students into thinking and acting in this direction. In the second part of the course, students are introduced to one of the basic software tools for the design.

learning outcomes

After successful completion of this course, students should:
• understand the importance of technical innovation in stimulating the development of society and entrepreneurship;
• be trained to evaluate and rank the level of technical innovation;
• be able to create innovative ideas and define development constraints;
• identify the necessary resources and the fulfillment of the postulates of innovative development;
• recognize the physical, biological, ergonomic, aesthetic and environmental incentives and trends for innovative development of technical systems.

theoretical teaching

1. What is the technical system?; 2. The needs and the concept of technical innovation; 3. Creating a technical system and innovations; 4. Historical trends in technical innovation; 5. Planning of technical innovation; 6. The idea and how to get ideas for a new product; 7. The concept and importance of the functions of the technical system; 8. Transformation of the biological technology systems; 9. Harmonization of technical systems with the environment; 10. Creativity in developing new technical systems; 11. Software design tools

practical teaching

During semester students write essays giving an overview of existing technical systems used in a given field or activity. Systematized overview of existing technical systems should lead to the proposal of ideas for innovative technical solutions. For auditory exercises are more elaborate theoretical topics covered in classes in order to introduce students to the phenomena that need to discuss in essay, and to prepare for the tests. Elementary functions of software tools.

prerequisite
learning resources

1. Book - Tutorial: Ognjanović M: Innovative development of technical systems, University of Belgrade, Faculty of Mechanical Engineering 2014 2. Power-Point presentations with lectures available to students in the form of a hand-out materials. 3. presentations, animations, and movies on the construction solutions and innovative technical systems function. 4. Internet and search on the Internet of existing technical solutions and innovative systems. 5. Computer Classroom. 6. Moodle

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: 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: 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): 35

references
Ognjanović M: Innovative development of technical systems, University of Belgrade, Faculty of Mechanical Engineering 2014
Machine elements 1

ID: MSc-1090
responsible/holder professor: Ristivojević R. Mileta
teaching professor/s: Lazović-Kapor M. Tatjana, Marinković B. Aleksandar, Mitrović M. Rađivoje, Mišković Z. Žarko, Ristivojević R. Mileta, Rosić B. Božidar, Stamenić V. Zoran
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written
parent department: general machine design
semester.position: 3.3

goals

Introduce the students in solving of practical tasks in mechanical engineering. Teach students to understand components of mechanical systems, their functions, applications and variants of design solutions. Mastering the methods for calculation of operational safety, calculation of service life, and carrying capacity and also mastering the basics principles for machine elements design. Introduce the students to apply standards and other regulations in calculations and design of machine elements.

learning outcomes

After successful completion of this course, students should be able to:
• Recognize machine elements.
• Use of tolerance of dimensions, shape and position, and surface roughness.
• Perform basic calculations of strength of mechanical parts.
• Calculate and design shafts and axles.
• Select types of rolling and sliding bearings, calculate load capacity and design of installation.
• Design bolted joints and threaded load transmitters.

theoretical teaching


practical teaching

**prerequisite**

Defined by students curricula.

**learning resources**

Books>
- S Veriga.: Machine elements (volumes I and II) , Faculty of Mechanical Engineering, Belgrade

Handouts available on the web site or reproduced on paper:
- Lectures, questions and tasks for colloquiums
- Guidelines for project tasks
- Video presentation:
  - Simulation of mechanical elements operation,
  - Video presentation machine parts production and measurement
- Display of design solutions
  laboratory:
  - Show of machine elements, parts and components,
  - Demonstration of machine elements testing
  - Simulation of machine parts operation and production.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 6
laboratory exercises: 4
calculation tasks: 10
seminar works: 0
project design: 6
consultations: 4
discussion and workshop: 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: 2
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: 30
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 10
final exam: 50
requirements to take the exam (number of points): 26

references

Matek W., Muhs D, Wittel H., Becker M: Roloff/Matek Machinenelemente, - Friedr. Vieweg & Son Verlag, Braunschweig
Decker : Machinenelemente - Cartl Hanser Verlag, Munchen.
Shigley J.: Mechanical Engineering Design, - McGrow Hill
Collins J: Mechanical Design of Machine Elements and Machines, - John Wiley and Sons
Machine elements 2

**ID:** MSc-1091  
**responsible/holder professor:** Ristivojević R. Mileta  
**teaching professor/s:** Lazović-Kapor M. Tatjana, Marinković B. Aleksandar, Mitrović M. Radivoje, Mišković Z. Žarko, Ristivojević R. Mileta, Rosić B. Božidar, Stamenić V. Zoran  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** general machine design  
**semester.position:** 4.3

goals

Introduce the students in solving of practical tasks in mechanical engineering. Teach students to understand components of mechanical systems, their functions, applications and variants of design solutions. Mastering the methods for calculation of operational safety, calculation of service life, and carrying capacity and also mastering the basics principles for machine elements design. Introduce the students to apply standards and other regulations in calculations and design of machine elements.

learning outcomes

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

- Identify and monitor the current (transformation) of mechanical power in transmitters.
- Select the design parameters and conceptual design of the friction power transmitters.
- Determine the dimensions, select geometric parameters and design gears in the gear transmitters.
- Calculate gear load capacity and operating safety (spur, helical, bevel and worm gears).
- Calculate load capacity and lifetime of belt and chain transmission pairs.
- Select and design of couplings (rigid, flexible, knuckle, toothed, friction).

theoretical teaching

Principles of mechanical power transformation, the basic equations of the transformation of mechanical power, transmission ratio and power transmission efficiency. Friction transmission units, the basic principles, performance, slip and wear in the contacts, materials of machine parts. Cylindrical gears (spur and helical), the basic principles of the teeth mashing, the geometry and kinematics of meshed gears. Strength and load capacity of cylindrical gears. Bevel and worm gears. Belt transmission pairs, load, stresses, service life. Chain transmission pairs. Couplings: rigid, flexible, knuckle, toothed, friction.

practical teaching

Determination of transmission ratios, torque, speed of rotation and power flows in gear structure, (power cabling in transmission unit). Calculation of gear teeth dimensions, gear dimensions, center distance, contact ratio etc. Strength (load capacity) of gears (spur, helical, bevel, worm). Calculation of belt transmission pairs geometry, loads, stresses, service life. Calculation of coupling load capacity. Display functions and design solutions, tests of strength and load capacity in the laboratory. Monitoring and instructing students to process project tasks.

prerequisite
Defined by students curricula.

**learning resources**

Books:
- S Veriga.: Machine elements (volumes I and II), Faculty of Mechanical Engineering, Belgrade

Hendauti available on the web site or reproduced on paper:
- Lectures, questions and tasks for colloquiums
- Guidelines for project tasks

Video presentation:
- Simulation of mechanical elements operation,
- Video presentation machine parts production and measurement
- Display of design solutions

Laboratory:
- Show of machine elements, parts and components,
- Demonstration of machine elements testing
- Simulation of machine parts operating and production.

**number of hours**

Total number of hours: 75

**active teaching (theoretical)**

Lectures: 30

**active teaching (practical)**

Auditory exercises: 6
Laboratory exercises: 4
Calculation tasks: 10
Seminar works: 0
Project design: 6
Consultations: 4
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: 2
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: 30
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 10
final exam: 50
requirements to take the exam (number of points): 26

references

Matek W., Muhs D, Wittel H., Becker M: Roloff/Matek Machinenelemente, - Friedr. Vieweg & Son Verlag, Braunschweig
Decker : Machinenelemente - Cartl Hanser Verlag, Munchen
Shigley J.: Mechanical Engineering Design, - McGrow Hill
Collins J: Mechanical Design of Machine Elements and Machines, - John Wiley and Sons
Mechanical Engineering Praxis

ID: MSc-0879
responsible/holder professor: Miloš V. Marko
teaching professor/s: Miloš V. Marko
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 5
final exam: written
parent department: general machine design
semester.position: 4.5

goals

Introduce the students about all mechanical fields which are the subject of studying in Mechanical faculty from the point of view of practical work in each particular field: Control Engineering, Biomedical engineering, Naval architecture, Aerospace engineering, Design in mechanical engineering, Railway mechanical engineering, Welding and welded structures, Engineering of biotechnical systems, Industrial engineering, Information technologies, Motor vehicles, Internal combustion engines, Food industry engineering, Production engineering, Process engineering and environment protection, Weapon systems, Thermal power engineering, Material handling, constructions and logistics, Thermal science engineering, Hydropower engineering, Computational Engineering, Mechanics.

learning outcomes

The students will be introduced about practical work in all fields which are the subject of studying in Mechanical faculty.

theoretical teaching

Presentation of the any particular field - study module at Mechanical faculty.

practical teaching

Introduction to the resource of module's at the faculty for practical training.

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, laboratories, handouts.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 33
active teaching (practical)

auditory exercises: 0
laboratory exercises: 0
calculation tasks: 0
seminar works: 38
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: 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: 45
project design: 0
final exam: 45
requirements to take the exam (number of points): 55

references

professor's handouts in electronic form (Moodle)
Skill Praxis B - DUM

ID: MSc-1226  
responsible/holder professor: Miloš V. Marko  
teaching professor/s: Miloš V. Marko  
level of studies: B.Sc. (undergraduate) academic studies  
ECTS credits: 1  
final exam: seminar works  
parent department: general machine design  
semester.position: 4.5

goals

Introduction to the field of Design in ME particularly in terms of practical application in mechanical engineering (functional, aesthetic, technological, market). Identifying the basic functions of design and its importance in the field of product development, in the field of market competence and in the field of harmonization of technical solutions with the environment. Consideration of the technological aspects of product development in mechanical engineering.

learning outcomes

After completion of the Skill Praxis - B - DUM, students should gain experience in recognition of:

• Technical characteristics of the system, functional, technological and aesthetic;
• Technologies and their qualities for the realization of technical systems;
• Market and social needs for certain types of TS.
• Phase of the life cycle of TS (design, manufacturing, exploitation, recycling).

theoretical teaching

Introduction, aim, content and program of work.

practical teaching

Practical work includes study visits to organizations engaged in the development and design of products, organizations dealing with technological realization (making) products in mechanical engineering and organizations involved in the distribution of these products to market. This may be the organization for aesthetic product design (industrial design), for engineering design (construction) products, production, trade organizations which deals with products in mechanical engineering. The practice can be done abroad. During practice students keep a journal in which entries describe operations performed, observations and conclusions. After completed practice, sudent creates a report that defends in front of teacher. The report shall be submitted in the form of a seminar paper.

prerequisite

-

learning resources

Organizations that includes all the continent’s 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 Praxis B - MFB

ID: MSc-1227
responsible/holder professor: Miloš V. Marko
teaching professor/s: Miloš V. Marko
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 1
final exam: seminar works
parent department: general machine design
semester.position: 4.5

goals

Practical experience in ambient similar to the ambient where the graduated student - mechanical engineer will realize his own professional carrier.
Recognizing the basic functioning of the business systems especially in domain of development, design and manufacturing of the mechanical systems.

learning outcomes

Students can reach practical experiences about the organization and functioning the business systems that deal in mechanical engineering.
Student may be introduced in business communication, design processes, development processes and manufacturing.

theoretical teaching

Introduction, aim, content and program of work.

practical teaching

The skill praxis is organized in a way which is the most appropriate for the student.
Practical work must be realized in the company where the mechanical engineering is the primary occupation. What the student will work, see or follow must be defined in coordination with the professor. Generally, student can realize practical work in: manufacturing companies design companies, companies which work maintenance in mechanics or in laboratories that belong to the Mechanical faculty.
After finishing the practical work, the student must prepare the Report and this Report needs to be defended in front of professor.

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: 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**
Basics of fluid flow measurement techniques

ID: MSc-0807
responsible/holder professor: Čantrak S. Đorđe
teaching professor/s: Čantrak S. Đorđe
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: seminar works
parent department: hydropower engineering
semester.position: 6.4

goals

The goal of this course is to introduce fundamentals of measurement techniques to the students, with emphasize on flow measurement techniques. The main goal is the study of significant terms in metrology, as well as principles of classical and contemporary measuring techniques, flow visualization methods and basic statistical data analysis. It is an intention to train students for complex challenges in fluid flow measurements with scientific and engineering applications.

learning outcomes

Upon successful completion of this course, students should be able to:
1. calibrate contemporary and classical devices for measuring speed, flow and pressure,
2. apply following anemometers: laser Doppler anemometer (LDA), particle image velocimetry (PIV) probe with hot wire (HWA), as well as other classical methods,
3. organize and carry out testing of hydraulic machines (pumps and fans),
4. perform data acquisition with modern measurement and acquisition systems, as well as their statistical analysis.

theoretical teaching


practical teaching

1. Types of pressure and anemometer probes.
2. Calibration airtunnels for anemometer probes.
3. Test of the flow uniformity in calibration airtunnel jet with Pitot probe.
5. Calculation of the uncertainty of measurement in calibration of pressure measuring device.
6. Softwares for data acquisition and processing. Examples in anemometry and pressure, flow, humidity, force and temperature measurements.
8. Fluid flow visualization with filaments, fog machine, atomizer and etc.

**prerequisite**

Not applicable.

**learning resources**

1. Textbooks listed in the references and list of literature provided for students.
2. Lecture handouts.
3. Laboratory for hydraulic machines - calibration test rigs and equipment.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 3
laboratory exercises: 15
calculation tasks: 0
seminar works: 12
project design: 0
consultations: 2
discussion and workshop: 3
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: 0
final exam: 4

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

feedback during course study: 5
test/colloquium: 0
laboratory exercises: 20
calculation tasks: 0
seminar works: 45
project design: 0
final exam: 30
requirements to take the exam (number of points): 21

**references**
Vušković I. (1977): Fundamentals of Measurement Technique, Faculty of Mechanical Engineering University of Belgrade, Belgrade. (in Serbian)
Fundamentals of turbomachinery

ID: MSc-0999  
**responsible/holder professor:** Božić O. Ivan  
**teaching professor/s:** Božić O. Ivan  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** hydropower engineering  
**semester.position:** 6.3

**goals**

Achievement of basic academic competence in the field of turbomachinery. Obtaining fundamental theoretical and practical knowledge about the principles of energy transfer process in turbomachinery. Mastering the knowledge of the essential components, proprieties and particularities of various types of turbomachinery. Development of the ability to apply turbomachinery in various energy systems and to calculate their main parameters by the acquired basic knowledge use.

**learning outcomes**

On successful completion of this course the students will be able to:
- recognize different types of turbomachinery and describe the principles of their operation in various power plants and energy systems,
- explain fundamental fluid flow and thermodynamic processes in turbomachinery,
- describe and differentiate the essential components of various turbomachinery (hydraulic turbines, pumps, fans and turbocompressors) from the point of their functioning and roles in the energy transfer process,
- define and calculate main specific geometry and energy parameters of turbomachinery,
- develop and implement the acquired knowledge in order to efficiently continue further improvement in the specialized courses for each particular type of turbomachinery.

**theoretical teaching**


**practical teaching**
Auditory exercises and calculation examples: Fundamentals of turbomachinery operation. Historical development, classification, properties and application of turbomachinery. Energy balance. Calculation of basic and main parameters of turbines, pumps, fans and compressors - specific work (isentropic, polytropic, real, head), discharge, torque, powers, efficiencies, hydraulic and mechanical power losses. Application of Euler equation for the turbomachinery. Determination of velocity triangles, relation between specific works of turbomachinery unit and impeller/runner, the degree of reaction and main construction dimensions. Determination and application of unit and specific turbine dimensionless parameters in practice. Calculation of suction height.

Explanatory exercises in the laboratory for hydraulic machinery and energy systems: presentation of different types of turbomachinery constructions, essential components and their functions. Installations for testing turbines, pumps, fans and compressors. Presentation of numerical experiment – the fluid flow simulation in turbomachinery using the contemporary CFD techniques.

Visiting the electric power systems, waterworks and process industry with the aim of demonstrating the practical operation of turbomachinery in the installations and plants.

prerequisite

learning resources

Books listed in the literature and more. Auditory exercises handouts. Laboratory hydraulic machines and energy systems - devices, installations for testing turbines, pumps, fans, 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: 5
calculation tasks: 10
seminar works: 0
project design: 0
consultations: 3
discussion and workshop: 2
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: 5
test/colloquium: 40
laboratory exercises: 5
calculation tasks: 10
seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 30

references

N. M. Obradović: Osnove turbomašina, Građevinska knjiga, Beograd, 1973
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.

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

Knowledge of fluid mechanics. It is 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

Pfleiderer C. Die Kreiselpumpen fuer Fluessigkeiten und Gaese. Springer Verlag, 1965
Eck B. Fans. Pergamon Press, 1972
Skill Praxis B - HEN

ID: MSc-1209  
**responsible/holder professor:** Ilić B. Dejan  
**teaching professor/s:** Ilić B. Dejan  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 1  
**final exam:** seminar works  
**parent department:** hydropower engineering  
**semester.position:** 4.5

**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**

Desirable knowledge in Constructive geometry, Engineering graphics (AutoCAD, Catia, and similar software programs).

**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,

**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
goals

Acquisition of vocational lexis related to fundamental concepts in sciences (measures, physical quantities). Adopting terminology related to branches of mechanical engineering. Training students to use vocational literature in different fields of engineering. Developing reading and writing skills in engineering English.

learning outcomes

Upon the completion of this course, students will be able to:
- use vocabulary and text structures appropriate for engineering English,
- prepare and deliver a presentation in English related to mechanical engineering,
- write a CV and motivation letter in English.

theoretical teaching


practical teaching

Lexical and grammatical exercises (multiple choice questions, gap-fill activities, answering questions, translation). Individual and group work. Oral presentations.

prerequisite

Defined by the curriculum of the study programme/module.

learning 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: 2  
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: 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: 0  
project design: 25  
final exam: 65  
requirements to take the exam (number of points): 20

**references**
English 2

**ID:** MSc-0489  
**responsible/holder professor:** Vesić-Pavlović S. Tijana  
**teaching professor/s:** Vesić-Pavlović S. Tijana  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 2  
**final exam:** written  
**parent department:** industrial engineering  
**semester.position:** 2.5

**goals**

Acquisition of vocational lexis related to different engineering areas (engineering materials, machine members, internal combustion engines, aeronautical engineering, artificial intelligence). Developing oral and translation skills in engineering English.

**learning outcomes**

Upon the completion of this course, students will be able to:
- use mechanical engineering vocabulary,
- analyze and adequately translate engineering texts into Serbian,
- use passive forms in oral and written language.

**theoretical teaching**

Terminology of the fields of engineering materials, machine members, pumps, turbines and internal combustion engines, aeronautical engineering, artificial intelligence. Interpreting charts. Descriptive grammar of English: verbs, active and passive voice, relative clauses.

**practical teaching**

Lexical and grammatical exercises (multiple choice questions, gap-fill activities, answering questions, translation). Individual and group work. Analyzing texts in English, making summaries and translation.

**prerequisite**

Defined by the curriculum of the study programme/module.

**learning 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: 2
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: 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: 0
project design: 25
final exam: 65
requirements to take the exam (number of points): 20

references
Sociology and Economy

**ID:** MSc-1038
**responsible/holder professor:** Dondur J. Nikola
**teaching professor/s:** Dondur J. Nikola
**level of studies:** B.Sc. (undergraduate) academic studies
**ECTS credits:** 4
**final exam:** written
**parent department:** industrial engineering
**semester.position:** 2.4

**goals**

The aim of this subject is that students get know basic principles of fundamental social science, sociology and economics, and become able to understand the most important appearances and processes in modern societies, especially in societies within globalization. The aim is to more competencies for self and responsible taking part in processes of professional and public decisions.

Topics covered in this course include sociology as science, culture, socialization, social groups, social organization, education, deviance, crime, class, inequality, race and ethnicity, gender, family, social change, technology and population. The course stresses the learned nature of human behavior as a shared product of the ongoing interaction of individuals and groups within the changing institutional structure we call society.

Also, topics in Economics presents basic concepts and theories in many areas of contemporary economy. Topics covered in this class include key aspects of micro and macroeconomics.

**learning outcomes**

By adopting of the programme of this course the students strengthen their own abilities to understand critically the most important controversies of development of all modern societies, especially of transitional ones, such as ours. Modern theoretical concepts and empirical methods are of special importance.

The module covers the themes of social integration, power, social change, the individual and society, as well as examining the social and economic basis of culture, beliefs, consciousness and general social development.

**theoretical teaching**

practical teaching

The practical work (exercise) is consisted of discussions and workshops with additionally chosen themes relevant from theoretical as well as practical point of view. The point out will be on sociological and economic analysis of modern societies, comparing to the others analytical and methodological procedures. Characteristic cases from the experience of development of our society in ongoing transition and globalization will be analyzed. Also, this part will be used for consultations for preparation and defense of seminar works.

prerequisite

At least 50 points, when the most important are the points from practical exams.

learning resources

Cited literature, handouts and the power-point presentations. Also, internet adresses, other literature according to the professor’s recommendation, especially for seminar works presentations are important.

Slobodan Pokrajac, Nikola Dondur, Introduction to Economics, (in Serbian), Proleter, Bečej, 2009

number of hours

total number of hours: 45

active teaching (theoretical)

lectures: 18

active teaching (practical)

auditory exercises: 9
laboratory exercises: 0
calculation tasks: 0
seminar works: 4
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: 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: 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

Industrial ergonomics

ID: MSc-0075
responsible/holder professor: Žunjić G. Aleksandar
teaching professor/s: Žunjić G. Aleksandar
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: oral
parent department: industrial engineering
semester.position: 5.5

goals

The aim of this course is the acquisition of basic academic knowledge in the field of industrial ergonomics, which can be used for designing, evaluation 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 engineering problems.

learning outcomes

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

• Identify common factors that are important for the successful operation of the man-machine-environment system
• Determine the reliability of a man and a system from the ergonomic aspect
• Identify the factors that have the impact on the visibility, legibility and readability of alphanumeric information
• Apply the acquired knowledge on proper selection and coding of controls
• Recognize the importance of applying the anthropometry to design products and jobs and apply basic anthropometric criteria in the design of systems
• Apply the basic principles of biomechanics to the design and execution of working tasks
• Calculation and assess physical fatigue of man while performing different tasks
• Apply different modalities of presentation of information depending on the specific situation, in accordance with the theory of signal detection, as well as the theory relating to the receipt and processing of information
• Carry out an assessment of mental workload
• Perform an assessment of noise of variable levels, based on the criteria and procedures for assessing the harmful effects of time-varying noise
• Estimate adverse effects of vibration on the human body
• Estimate effects of different levels of acceleration on the human body
• Apply ergonomic recommendations for the design of computer interfaces
• Apply in practice different methods for assessing the usability of a system
• Calculate and assess the usability of websites

theoretical teaching


**practical teaching**

Laboratory exercise: Evaluation of changable noise - here are presented the criteria and procedure for assessing of the harmful effects of noise and performs an estimation of harmful effects of noise in the selected workplace. Laboratory exercise: Assessment of physical work effort - here are presented the criteria and procedure for assessing physical effort during the work, and the work that is performed in laboratory conditions is an object of estimation. Making of project - Assessment of usability of software / web presentation. 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.

**prerequisite**

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. Fonometer - available in the lab. 417. CAD working station, available in the lab. 455. Software package Ergoeaser, available in the lab. 455.

**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: 8
project design: 6
consultations: 5
discussion and workshop: 1
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: 4
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.
Maintenance management

ID: MSc-0414
responsible/holder professor: Bugarić S. Uglješa
teaching professor/s: Bugarić S. Uglješa
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written
parent department: industrial engineering
semester.position: 6.4

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 and complex 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
malfunction, 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

Production and Operations Management 1

ID: MSc-0602
responsible/holder professor: Spasojević-Brkić K. Vesna
teaching professor/s: Spasojević-Brkić K. Vesna
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written
parent department: industrial engineering
semester.position: 5.4

goals

The aim of this course is to acquire knowledge and practical skills in the field of theory and practice of the production management. Mechanical engineers after taking this course are trained to perform diagnostics and to apply methods for raising the general level of enterprise organization and rationalization of operations and production. Methods and techniques for production and operations management are useful in everyday tasks of mechanical engineers irrespective of the job specialization.

learning outcomes

Upon successful completion of this course, student acquires the following competencies: 1. Diagnosing the state of the organization of the company, 2. Organizational structure design, 3. Tools for rationalization 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 organization and 5. explain the connection between the above mentioned competencies to make decisions, and, accordingly upon the course completion is able to design organizational structure and make rationalization 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-organizational structure of manufacturing enterprises with particular emphasis on the organizational structure of the production function micro level. Solution of practical problems in the areas of linear programming, network planning - CPM, inventory management and capacities calculations and production cycle time measurement. The
corporate performance measures calculation.

prerequisite

Students need to enroll 5th semester.

learning resources

1. Bulat V., Organization of production, Faculty of Mechanical Engineering, Belgrade, 1999. (in Serbian)
3. M., Industrial Engineering, Volume 1, The organization and planning of production processes, Faculty of Mechanical Engineering, Belgrade, 1996. (in Serbian)
6. Handout

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 1
laboratory exercises: 0
calculation tasks: 6
seminar works: 0
project design: 18
consultations: 5
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: 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

Bulat V., Organization of production, Faculty of Mechanical Engineering, Belgrade, 1999. (in Serbian)
Jovanovic T., Milanovic D. D., V Spasojevic., Modern organization and management, Faculty of Mechanical Engineering, Belgrade, 1996. (in Serbian)
Klarin M., Industrial Engineering, Volume 1, The organization and planning of production processes, Faculty of Mechanical Engineering, Belgrade, 1996. (in Serbian)
Production process optimization

ID: MSc-1170

responsible/holder professor: Misita Ž. Mirjana

teaching professor/s: Veljković A. Zorica, Misita Ž. Mirjana

level of studies: B.Sc. (undergraduate) academic studies

ECTS credits: 6

final exam: written

parent department: industrial engineering

semester.position: 4.4

goals

The aim of this course is to familiarize students with the basic characteristics of production processes, with special emphasis on small production companies. The first goal is formation and planning of the production process for a product through theoretical preparation. Another objective of the course is theoretical and practical familiarization of students with the basic characteristics of enterprises functioning with respect to all elements related to production processes. Familiarization of students with basic objective goals and real constrains which influence on production process flow.

learning outcomes

Upon successful completion of this course, students should be able to:
- Recognize and distinguish the characteristics of the production processes,
- Analyze the efficiency of production processes,
- Identify problems which may arise in the manufacturing process,
- Set objective goals,
- Identify real constrains on production process,
- Select and apply appropriate optimization production process methods,
- Select and propose appropriate solutions to improve production processes,
- Identify adequate information system for managing production processes,
- Evaluate implementation of the designed solution.

theoretical teaching

The theoretical part of this course: the first part introduces students to the organizational structures related to production processes, recursive process of forming a new product. Process of forming the material component, with single-level, hierarchical, technological and temporal formation of components, with a budget of progressive work. Duration of the production cycle. Manipulation, management and monitoring material flow through production processes and methods and characteristics of material storage, raw materials and products.

In the second part of this course the focus is placed on analysis of available production resources - machines, material and man-power. Identification of real constrains according to available real constrains. Analysis of optimal criteria, mostly minimum costs, maximum profit, maximum capacity utilization of machine capacities, or other production resources. Analysis of methods for production process optimization. Analysis of information systems for integral production processes management (ERP).

practical teaching

Practical part of this subject includes team work in groups of three students. Students choose
a product that will produce, define its characteristics, form a component of the material, technological and operational component. The production of a specific series is formed on the basis of the limits set in the volume of production and factory capacity and available manpower.

In second part of this course is planned: analysis of real example of production process and calculation of utilization coefficient each of production resources. Design of real constraints and optimization criteria. Application of production process optimization methods for suggestion of optimal production volume.

**prerequisite**

Enrolled the fourth semester of undergraduate studies.

**learning resources**

Electronic form of highlights from lectures and exercises will be available to the students. There will also be shown the appropriate contemporary models and applications on computers.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 6
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 14
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: 40
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 5
final exam: 45
requirements to take the exam (number of points): 30

references

Bulat V., 1999, Organization of production, FME, Belgrade /In Serbian/
Salvendy G., 2001, Handbook of Industrial Engineering, John Wiley & Sons, Canada
Skill Praxis B - IIE

ID: MSc-1200
responsible/holder professor: Misita Ž. Mirjana
teaching professor/s: Misita Ž. Mirjana, Spasojević-Brkić K. Vesna
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 1
final exam: written
parent department: industrial engineering
semester.position: 4.5

goals

The aim of this course is introduction of students to the production processes and to acquire practical knowledge in the field of work organization in industrial enterprises. After taking this course, students will be familiar with the tasks of diagnosis and improvement the overall organization in the enterprises. Methods and techniques the students learn will be useful in everyday tasks of mechanical engineers.

learning outcomes

Upon successful completion of this course, students should be able to:
- Differ production processes in the company,
- Identify the product documentation and its flow,
- Differ types of production plans,
- Choose the resources needed for production.

theoretical teaching

Theoretical classes: The role and importance of professional practice - Industrial Engineering. Organization of visits to the factories of metal processing complex in Belgrade, where the students will obtain the necessary knowledge and practical skills in the field of planning and organization of production processes. Students will get a theoretical background in the field of the following disciplines: 1. organization of production processes in the enterprise, 2. internal transport, 3. terotechnological process, 4. functions of production planning, 5. supply and storage of materials and others.

practical teaching


prerequisite
Enrolled 4th semester of undergraduate studies.

**learning resources**

As part of professional practice, it is necessary to arrange a visit to industrial enterprises. Students should record the state of the manufacturing process and obtain product documentation that will be shown in the report of professional practice.

**number of hours**

total number of hours: 90

**active teaching (theoretical)**

lectures: 0

**active teaching (practical)**

auditory exercises: 20
laboratory exercises: 0
calculation tasks: 0
seminar works: 0
project design: 30
consultations: 0
discussion and workshop: 0
research: 30

**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: 0
project design: 40
final exam: 60
requirements to take the exam (number of points): 0

**references**
Bulat, V., 1999, Organization of production, FME, Belgrade, /In Serbian/
T. Jovanovic, D. D. Milanovic, Spasojevic, V., 1996, Contemporary organization and management of production, FME, Belgrade, /In Serbian/
Basic WEB projecting

ID: MSc-0432

responsible/holder professor: Mitrović B. Časlav

teaching professor/s: Bengin Č. Aleksandar, Vorotović S. Goran, Mitrović B. Časlav

level of studies: B.Sc. (undergraduate) academic studies

ECTS credits: 6

final exam: project design

parent department: information technologies

semester.position: 4.4

goals

Course objective:

• To acquaint students with the importance and benefits of Web and Web programming.
• To make students adopt some of the methodologies of data preparation for Web
• To make students know the basic Web application to accept and display the data.
• The creation, introduction and use of the Web Site
• Determining the functionality of your own web site

learning outcomes

The acquired knowledge allows students:

• to prepare, make and display their own skills,
• to determine the functionality of the Web site,
• to prepare and implement Web applications,
• to prepare and implement a simple Web site,
• working in a team, prepare and implement any Web site.

theoretical teaching

WEB ARCHITECTURE (Internet–Web; specific Web application, basics of HTTP, WAP protocol) LANGUAGE HTML, XML.

BASICS OF JAVA Java abstract layer; (Java servlets and Java applets, network protocols)

PROGRAMMING ON THE USER (hierarchy, event and timing component management ; introduction to ASP)

USING database (JDBC, PHP, ASP, transaction models, distributed computing, CORBA, RMI, DCOM)

PREPARATION OF WEB DOCUMENTS (legal terms, the control input, testing, authoring tools according to W3C; criteria)

WEB DESIGN (planning, implementation, design of Web pages; typography, editorial style, graphics, graphic file formats, image maps, multimedia)

Intelligent agents. SAFETY (introduction, architecture, ways of implementation, application, security on the Web; Wessex protocols, identification and verification)

DESIGN PRESENTATION AVAILABLE TO INVALIDS (various disabilities, visual, auditory, motor and cognitive disabilities, limitations and instructions)

practical teaching

Discussion on advantages and disadvantages of the used tools. Posting remarks on the network to other authors of presentation. Compiling all the presentations and making the home page. Selecting editor to write the code. Creating personal Web site. Formatting documents in HTML. Formation of the list.; Creating hyperlinks, addressing, use of images, forming tables (Table); frames or zone (frame); creating forms. Selecting the best tool for Web applications. Individual work tasks using HTML, XML, XHTML, JavaScript and Java. Preparation for the project of team working on Web site. Analysis of the goals, objectives and anticipating problems that may occur in the preparation of Web site. Defining the profile and requirements. Presentation plan. Model of presentation. Realization of experimental Web Site.

prerequisite

'defined by curriculum of study program / modules'

learning resources

To successfully master the subject, it is necessary the use of textbooks, manuals for the project, handouts, Internet resources. IT equipment (appropriate hardware and software) ICT, available in the laboratory 457)

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: 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: 5
calculation tasks: 0
seminar works: 10
project design: 20
final exam: 30
requirements to take the exam (number of points): 35

references

Database Design

ID: MSc-0259

responsible/holder professor: Radojević LJ. Slobodan
teaching professor/s: Vorotović S. Goran, Lazović M. Goran, Mitrović B. Časlav

level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: project design
parent department: information technologies
semester.position: 6.4

goals

Course objective:
• Analysis of problems in the creation of a set, data collection, database.
• Step-by-step accepting the methodology of logical and physical design and the database.
• Analysis of selected problems typical for company business.
• Accurate and clear introduction to the DBMS and SQL.

learning outcomes

The achieved knowledge allows:

• identified the real object data that becomes information,
• obtained data at the basic level get systematized and logical prepar,
• logical data prepared at the basic level get copied to database,
• obtain informations from existing database using a higher level base of SQL.

theoretical teaching

The development of software systems is teamwork (starting and iterative development, business requirements).
The modeling and design (physical and logical model; objects - entities and business functions).
Design from implementation to the realisation (charts, diagrams and business functions, database designer).
Business modeling and design (the chart; activities related to business function, visualization).
For the definition of requirements (alignment with the requirements of users; stages of life of a software system).
Analysis and design of the (overlapping analysis, design and implementation; class diagram; meeting the demands of business functions).
Models for design (profiles, unstandard diagrams).
The physical realization (local or distributed nature of database, DBMS, linking of data included in the database).
UML in the design (using UML and applications, modeling and design stages and monitoring constructs, evaluations of the project).

practical teaching

Practical work is based on case studies. It also fully complies with the theoretical teaching. Laboratory exercises are used for monitoring of seminar papers and final project.
**prerequisite**

Preferred:
Communication engineering.
Information integration of business functions.

**learning resources**

The necessary software for this case under the GNU license. If you use LINUX necessary UML immediately available. If you use another operating system UML can be downloaded from the appropriate Web site (see URL of cases) or in the URL in the case. 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: 6
laboratory exercises: 20
calculation tasks: 0
seminar works: 4
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: 5
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: 5
test/colloquium: 5
laboratory exercises: 0
calculation tasks: 0
seminar works: 60
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

**references**
Engineering communication

ID: MSc-0384
responsible/holder professor: Bengin Č. Aleksandar
teaching professor/s: Bengin Č. Aleksandar
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: project design
parent department: information technologies
semester.position: 3.5

goals

- Understanding the importance and gaining ground skills in the preparation and execution of communication with different customers (management, professional services, colleagues and clients).
- Introduction to the creation, presentation and use of engineering documentation.
  Computer processing of documentation
  - Identifying the basic functional units in companies, and learning about mutual communication these entities.
  - Understanding the basic documents that characterize the activities of companies.
  Preparation for the Computer processing of these documents.

learning outcomes

The acquired knowledge enables listener:
- to prepare, create and display their own skills.
- to prepare, make and present a report on the accomplished work.
- to prepare, perform and manage the presentation, discussion.
- to recognize the basic functional units of the company, and to notice interdependent.
- to recognize the basic documentation of the company, and
- to prepare the basic documentation for computer processing.

theoretical teaching

Communication (oral and written; parameters, the application of computers in communication).
Organizing communication (structure and content; defining, evaluating and managing information, organizing ideas and facts).
The speech (voice and body language, audience and management issues, and managing a set of discussion).
Engineering documentation (contracts, offers, CV, bills, invoices, technological documentation, reports).
The company as a generator of information (organizational units of small and medium enterprises; supplies; norms, accounting).
On some documents (inventories, stock lists, card material). Enterprises; supplies; norms, accounting).
A coding system (definition and enforcement, bar code, the parallel coding system, application in the supply).
BOM (modular, hierarchical, two-level, generic bill explosion, obtaining bill explosion).
Archive, send, protect documentation (copies, storage place, send the documentation; encryption).
About presentation (collection, processing, selection of information, organization and planning of the presentation).

**practical teaching**

Practical exercises consist of learning about the creation of technical documentation and documents for communication. It is also used appropriate software. Development of two projects CV and presentation of a problem with topic on information technology are the essence of practical training.

**prerequisite**

Without prerequisites.

**learning resources**

**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: 5
project design: 10
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: 15
calculation tasks: 0
seminar works: 15
project design: 20
final exam: 30
requirements to take the exam (number of points): 35

references
Information integration of business functions

ID: MSc-0614  
responsible/holder professor: Mitrović B. Časlav  
teaching professor/s: Mitrović B. Časlav  
level of studies: B.Sc. (undergraduate) academic studies  
ECTS credits: 6  
final exam: written+oral  
parent department: information technologies  
semester.position: 5.5

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 a business system.  
• The cybernetic definition of business processes and business domains.

Lesson 3  
• Theory for designing integrated digital company / factory.  
• CIMOS functional entities and the transfer of information across levels of business.

Lesson 4  
• Modeling for enterprise integration and a digital description of the business.  
• Modeling of educational and business environment is an integrated enterprise.
Lesson 5
- Engineering database / knowledge and standard interfaces.
- Design of technical systems, products and technologies.
- The documentation and electronic exchange of information.

Lesson 6
- Management of supply chain information integration with business partners.
- Optimal flow through the business sectors and facilities.
- Management and storage of materials throughout.

Lesson 7
- Information flow and integrated business tools.
- Flexible cell technology, systems and production facilities.
- Integrated maintenance and diagnostics.

Lesson 8
- An integrated system of quality assurance.
- Allocation of available resources.
- Multi-criterion decision-making.
- Procedures for quality.
- Quality standards.

Lesson
- Technology innovation in business.
- engineering and re-engineering of business processes and systems.
- Management costs.
- Information and communication infrastructure is an integrated enterprise.

10th Chapter
- The development and life cycle of the business system.
- The business profile and marketing companies / industries.
- 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
- unconditionally previously passed exams.

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**
Skill Praxis B - MIT

**ID:** MSc-1231  
**responsible/holder professor:** Mitrović B. Časlav  
**teaching professor/s:** Vorotović S. Goran, Mitrović B. Časlav  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 1  
**final exam:** seminar works  
**parent department:** information technologies  
**semester.position:** 4.5

**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 of information systems in the field of design, development and production software, as well as roles and tasks of mechanical engineering of information technology in such a 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, the manner of operation, management and engineering position and role of IT 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 that provide services in professional practice, 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 daily professional practice in which a student describes the activities and tasks performed by the expert during the practice.

**prerequisite**

Required: Basic IT knowledge. Prior knowledge acquired in previous modules listened MIT courses.

**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: 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): 35

references
Software engineering 1

**ID:** MSc-0529  
**responsible/holder professor:** Mitrović B. Časlav  
**teaching professor/s:** Bengin Č. Aleksandar, Vorotović S. Goran, Mitrović B. Časlav  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** information technologies  
**semester.position:** 6.3

**goals**

- Acquisition of basic skills in the preparation of projects related to software development are important for small and medium-sized companies.  
- Using some simple CASE tool for the design of some parts of the software.  
- The acquisition of skills which overcome the barriers to collaboration in teams to write and implement software.

**learning outcomes**

- to participate in the software team as a team member with special knowledge related to mechanical engineering,  
- to notice problems in the design and determine the problematic processes that can influence and some numerical mark on the project,  
- to prepare all the necessary data for modeling of certain parts of the software,  
- to prepare vallide documentation for software,  
- to participate in the implementation of the software with the contractor.

**theoretical teaching**

About software engineering, models and modeling (introduction, model theory, sketches of model ...; numerical parameters of model).  
Costs, prices and use the software (price, role of engineers and engineering, hardware and software, software with errors, types of software bugs).  
The organization of software projects (people, team development; individual roles; productivity and the impact on productivity, types of software projects, organization of software companies).  
Modeling of software development and processes (Pert; relationship with the client; different types of modeling and software development, process definition, classification process, process management).  
The documentation, software quality and metrics (goal; possibilities of electronic documents; standards for documentation, managing and documenting software defects and errors, audit software).  
Software for software development (special tools for developing GUI application components; code generators, and some examples of the application).  
Analysis, specification and drafting software (applications, data collection and processing, internal standards for the collection and processing of applications; importance of sketching and drafting software).  
Coding, testing and integration of software (the programming language, coding, editors; way of testing software, software integration and software integration strategy, expected and unexpected problems in integration of software).
Configuring and reliability of software (software configuration; special features of the software).
Re-engineering and reuse of software (software evolution in all aspects of the project).

**practical teaching**

Practical classes:
It consists of laboratory exercises that accompany the objects, and continuous monitoring of the project through the creation of the final four seminar papers.

**prerequisite**

Preferred: Web design in mechanical engineering, database design as well as objects 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 and software appropriate) ICT, available in the laboratory 457).

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 20

**active teaching (practical)**

auditory exercises: 6
laboratory exercises: 20
calculation tasks: 0
seminar works: 3
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: 3
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: 15
laboratory exercises: 15
calculation tasks: 0
seminar works: 15
project design: 20
final exam: 30
requirements to take the exam (number of points): 35

references
WEB projecting in mechanical engineering

ID: MSc-0070
responsible/holder professor: Mitrović B. Časlav
teaching professor/s: Bengin Č. Aleksandar, Vorotović S. Goran, Mitrović B. Časlav
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: project design
parent department: information technologies
semester.position: 5.4

goals

Course objective

• Understand the importance of Web sites in Mechanical Engineering,
• The creation, introduction and use of Web projects,
• Determining the functionality of Web projects,
• Preparing your own Web projects,
• Understanding and preparing the necessary documentation for the implementation of Web projects in Mechanical Engineering

learning outcomes

The acquired knowledge allows the:

• prepare, make and display your own skills,
• determine the functionality of all the specifications on the Web,
• prepare, perform and manage the designing of Web presentations,
• determine the technology of designing Web sites,
• recognize the requirements of the local machinery industry for Web presentations,
• create a necessary documentation of Web project,
• implement and collect Web project.

theoretical teaching

EVOLUTION OF THE SITE (customize and manage information in real time, Web services protocols, distributed applications, (in) compatibility of older protocols)
DOMAIN (generic and territorial domain, and the choice of the name, subdomains)
Web Design (theme, technology and design web site, templates, navigation, HomePage, content and readability of Web page; redesigned Web)
WEB SITE DESIGN (Web competition, testing and checking the Web)
CREATING AND PROGRAMMING Web - A (HTML, XML, XHTML, XSLT, CSS, HTAs)
CREATING AND PROGRAMMING Web - B (Java Script, Java)
CREATING AND PROGRAMMING Web - C (SQL, Server Side Scripting, Web services)
Web elements (tools and readers, Free Hosting, HTTP compression, and client-server setup, HTTP messages and warnings)
DESIGNING WEB SERVICES (life cycle of Web, development, analysis, technology and tools)
Web Development Presentation (price, vision, technology, design, price list, installation, maintenance and promotion of the website)

practical teaching

**prerequisite**

Preferred: Basic Web design and engineering communication as well as objects 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 and software appropriate) ICT, available in the laboratory 457).

**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: 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: 20
laboratory exercises: 5
calculation tasks: 0
seminar works: 20
project design: 20
final exam: 30
requirements to take the exam (number of points): 35

references
Elements of Construction and Mining Machines

**ID:** MSc-0044  
**responsible/holder professor:** Bošnjak M. Srđan  
**teaching professor/s:** Bošnjak M. Srđan, Gnjatović B. Nebojša  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** material handling, construction and logistics  
**semester.position:** 6.3

**goals**

Basic course goals (objectives): 1) introducing students with specificities of working process, design, modeling and calculation of construction and mining machines and appliances. 2) mastering practical skills which are necessary for selection, design and calculation of construction and mining machines.

**learning outcomes**

After successfully completing this course the student should be proficient in:
- Calculating basic parameters of various types of excavators and loaders;
- Calculating basic geometrical parameters of excavator buckets (length, height, depth) of known volume;
- Properly choosing and calculating basic geometrical parameters of bucket teeth;
- Performing resistance-to-excavation, bucket filling and dug material prism movement calculations;
- Determining loads acting on excavator boom, bucket and bucket holder;
- Develop a conceptual design of a mini-excavator.

**theoretical teaching**


**practical teaching**


**prerequisite**

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, Elements of construction and mining machines, - Instructions for project realization, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, 2008.,
4. Computers, Laboratory 516,
5. Software Mathlab, (Catia)

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: 15
consultations: 5
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: 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: 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
Fundamentals of steel structures

ID: MSc-0908  
responsible/holder professor: Gašić M. Vlada  
teaching professor/s: Gašić M. Vlada  
level of studies: B.Sc. (undergraduate) academic studies  
ECTS credits: 6  
final exam: written  
parent department: material handling, constructions and logistics  
semester.position: 5.5

goals

Basic goals of this course are: 1) introduction to logical principles in design and calculation of steel structures in mechanical engineering, 2) development of student creative skills in design of joints for characteristic structural systems throughout phases of idealization, parameterization and calculation.

learning outcomes

After the completion of the course, student is trained to:
- Set the suitable static model for different types of crane structures (like monorail and jib cranes) and analyze the effect of self-weight and payload
- Carry out basic stress proof of simple structures (beams, cantilever and frames)
- Calculate the welded joints of structures
- Calculate the bolted joints of structures
- Create the project of bolted connections for parts of I-beam girders
- Calculate the truss forces (for statically determined trusses) and perform the buckling analysis

theoretical teaching


practical teaching


prerequisite

Necessary courses: Mathematics 1, Strength of materials, Engineering materials 1.

learning resources

Laboratory (room 516) with computers and software.
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: 2
check and assessment of lab reports: 2
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: 30
laboratory exercises: 10
calculation tasks: 20
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references

Vlada Gašić: Osnove metalnih konstrukcija u mašinogradnji, Handbook, Faculty of Mechanical Engineering, Belgrade, 2017
Zoran Petković, Davor Ostrić: Metalne konstrukcije u masinogradji 1, Faculty of Mechanical Engineering, Belgrade 1996.
Material Handling Equipment

**ID:** MSc-0264  
**responsible/holder professor:** Zrnić Đ. Nenad  
**teaching professor/s:** Zrnić Đ. Nenad  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** material handling, constructions and logistics  
**semester.position:** 6.4

**goals**

The basic goal of this subject is to introduce students into the fundamentals of intralogistics (material handling equipment in intralogistics) and to enable achieving practical skills in engineering education and professional work such as are analysis of duty cycle of material handling equipment, selection, sizing and calculation of material handling equipment as elements of material handling and conveying machines.

**learning outcomes**

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

- recognize and describe the elements for lifting loads
- choose handling device according to the sort and characteristics of material
- determine the duty service classification of cranes and driving mechanisms
- perform calculation and selection of elements of hoist mechanisms
- perform and selection of elements of travelling mechanisms

**theoretical teaching**

Introduction into intralogistics and material handling equipment, significance of this field, historical development, classification, types and shapes of materials which have to be handled, application groups, classification into application groups. Elements of driving mechanisms (selection, sizing, calculation), ropes and chains, load handling attachments (hooks, triangular hooks, pulley blocks, slings), sheaves, drums, brakes and arresting gears. Mechanisms for lifting, hand operated hoisting devices (screw-type jack, rack-and-lever jack, hydraulic jack, lever hoist, chain hoist, rope hoist), crane crabs for unit, piece and bulk loads (crane clamps and grabs, carrier beams, electric lifting magnets, vacuum lifters, grab buckets, spreaders), hoists with electric motor, calculation of mechanisms. Mechanisms for translational movement of trolleys and cranes, resistance to motion, wheels, rails, slipping, braking, calculation of mechanism.

**practical teaching**

Video presentations of machines and principles of material handling equipment operation as well as hoists and cranes. Determination of application groups for hoists and cranes, based on the load spectrum. Calculation of the elements of the drives, calculation of force in rope and chain in slings and pulley blocks. Calculation of drums and shoe brakes. Calculation of lifting mechanism, selection and adoption of application group. Calculation of mechanisms for translational motion, the selection and adoption of application group, calculation and defining the diameter of wheel and rail, checking security against slipping. Laboratory exercises on the computer, 3D modeling of material handling equipment in CATIA software.
prerequisite

Desirable: Machine elements 2.

learning resources

1. Nenad Zrnic: Material handling equipment - Handouts and written lectures, 2011, DVL.
2. Slobodan Tosic, D. Ostric: Cranes, Faculty of Mechanical Engineering, 2005, KDA.
3. Computers, Laboratory 516, ICT / CAH
4. Software package CATIA, ICT / CSP

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: 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: 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: 45
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Skill Praxis B - TKL

ID: MSc-1196
responsible/holder professor: Bošnjak M. Srđan
teaching professor/s: Bošnjak M. Srđan
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 1
final exam: seminar works
parent department: material handling, construction and logistics
semester.position: 4.5

goals

The goal of the course is to inform students about the main examples of the devices and machines for material handling, their purpose and main parameters. The emphasis is given on cranes, conveyors and excavators.

learning outcomes

The successful completion of course students are introduced to:
1 Recognize main examples of the devices and machines for material handling in some industrial object, in different machinery catalogs or on internet
2 Comprehend the type of drives and purpose of these machines
3 Present the obtained knowledge in the form of report.

theoretical teaching

/practical teaching

Practical teaching is realized throughout the presentation which shows selected examples of the devices and machines for material handling, with basics for their purpose and main parameters. The presentation covers following topics:
• basic types of cranes (bridge, jib, gantry, tower)
• some devices for conveyors systems (belt/plate conveyors, screw conveyor, elevator)
• examples of construction and mining machines (excavators, bucket wheel excavator)
The course is holding in the classroom of the Department. Students are getting guide lines, within the workshop, for creating the report which should be their own work related to the given presentation.

prerequisite

/learning resources

1. Computer lab 516

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: 70
project design: 0
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: 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**

**Computational tools**

**ID:** MSc-0930  
**responsible/holder professor:** Cvetković S. Aleksandar  
**teaching professor/s:** Jandrlić R. Davorka, Lazović M. Goran, Radojević LJ. Slobodan, Cvetković S. Aleksandar  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 4  
**final exam:** written  
**parent department:** mathematics  
**semester.position:** 2.5

**goals**

The core of the subject is introducing the concepts of Matlab to the student.

**learning outcomes**

After finishing the course, students are capable of

- usage of integers and floating point numbers in Matlab
- usage of data structures in Matlab
- writing programs in Matlab
- reading and writing files in Matlab
- drawing of two and three dimensional figures in Matlab
- symbolic computations (derivatives, integrals, linear and differential equations) in Matlab

**theoretical teaching**


**practical teaching**

prerequisite

No prerequisites.

learning resources

number of hours

total number of hours: 45

active teaching (theoretical)

lectures: 15

active teaching (practical)

auditory exercises: 5
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: 2
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 3
test, with assessment: 0
final exam: 0

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

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

**references**

Programming in C

**ID:** MSc-0670
**responsible/holder professor:** Radojević LJ. Slobodan
**teaching professor/s:** Jandrlić R. Davorka, Lazović M. Goran, Radojević LJ. Slobodan, Cvetković S. Aleksandar
**level of studies:** B.Sc. (undergraduate) academic studies
**ECTS credits:** 4
**final exam:** written
**parent department:** mathematics
**semester.position:** 1.5

**goals**

The main objective of this course is to introduce students to the use C as programming language. It will be especially prominent characteristic to use C in Mechanical Engineering, characterized by analysis of the data collected in real time. Students must be:

- familiar with the data types and data structures;
- identify common use of the programming language C;
- use basic commands and C, and with their help solve simple engineering problems;
- familiar with using C for the analysis of data characteristic of Mechanical Engineering;
- familiar with basic programming techniques, which are characterized not only C.

**learning outcomes**

After successful completion of the course, students can:

- to recognize the possible use of C programming language to solve some problems in Mechanical Engineers.
- to gain basic knowledge of the principles of programming in C;
- to use the file.

**theoretical teaching**

Types and sizes of data. Constants.
Operators. Priority and order of calculation.
Statements and blocks.
Branch instruction program.
Loop.
Unconditional jump commands.
Basic concepts of functions. External variables. Policies range.
Using files.

**practical teaching**

Workshops with basic examples in C.

**prerequisite**

A high school mathematics and programming.

**learning resources**
The necessary software for this course is under the GNU license - free of charge.
If you use Linux then you C/C++ is available immediately.
If you are using another operating system, C/C++ can be downloaded from the corresponding web site (see URL) or the URL.
To run the software necessary to possess enough simplest PC.

**number of hours**

total number of hours: 45

**active teaching (theoretical)**

lectures: 15

**active teaching (practical)**

auditory exercises: 5
laboratory exercises: 10
calculation tasks: 0
seminar works: 0
project design: 0
consultations: 0
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: 2
test, with assessment: 0
final exam: 3

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

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

**references**

Mathematics 1

ID: MSc-1182
responsible/holder professor: Arandelović D. Ivan
teaching professor/s: Arandelović D. Ivan, Jandrlić R. Davorka, Pejčev V. Aleksandar, Radojević LJ. Slobodan, Spalević M. Miodrag, Cvetković S. Aleksandar
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: mathematics
semester.position: 1.1

goals

The aim of the course Mathematics 1 is to introduce students to basics of the following topics: Vector algebra, matrices and determinants, planes and lines in analytic geometry, differential calculus of real functions in one real variable, curves as hodographs of vector functions.

learning outcomes

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

1) solve systems of linear algebraic equations, and analyzing its solution;

2) solve basic problems of analytic geometry, by applying learned techniques of matrix calculus;

3) calculate limits and derivates of the real-valued and vector–valued functions of one independent real variables;

4) analyzing real-valued and vector–valued functions of one independent real variables, by applying learned techniques of differentiation calculus;

5) solve basic geometric problems by applying learned techniques of differentiation calculus;

6) to investigate lines defined as hodograph of vector valued functions by application of differentiation calculus.

theoretical teaching

Vector algebra, matrices and determinants, system of linear equations, equations of planes and lines, planar quadratic curves, quadratic surfaces, notion of a function, basic elementary real functions in one real variable, limit and continuity of a real function, differentiation of real functions in one real variable, applications of differentiation in analyzing functions, basic theorems on differentiable functions (Rolle’s, Lagrange's and Cauchy's theorems, L'Hospital rule, Taylor's theorem), curves as hodographs of vector functions, natural trihedron, curvature and torsion of a curve, osculating circle, evolute and involute of a plane curve.

practical teaching

Vector algebra, matrices and determinants, system of linear equations, equations of planes
and lines, planar quadratic curves, quadratic surfaces, notion of a function, basic elementary real functions in one real variable, limit and continuity of a real function, differentiation of real functions in one real variable, applications of differentiation in analyzing functions, basic theorems on differential functions (Rolle's, Lagrange's and Cauchy's theorems, L'Hospital rule, Taylor's theorem), curves as hodographs of vector functions, natural trihedon, curvature and torsion of a curve, osculating circle, evolute and involute of a plane curve.

prerequisite

The course attendance condition is determined by the curriculum of study program.

learning resources

Lesson 1, Lesson 2, Lesson 3, Lesson 4, Lesson 5, Lesson 6, Lesson 7, Lesson 8, Lesson 9.
All the necessary literature is on:
http://147.91.27.133 or ftp://147.91.27.133

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 35
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: 5
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

D. Tošić, M. Albijanić, D. Milenković, Elements of differentialal and integral calculus, Službeni glasnik, Beograd 2012
Mathematics 2

**ID:** MSc-1183  
**responsible/holder professor:** Pejčev V. Aleksandar  
**teaching professor/s:** Arandelović D. Ivan, Jandrlić R. Davorka, Pejčev V. Aleksandar, Radojević LJ. Slobodan, Spalević M. Miodrag, Cvetković S. Aleksandar  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** mathematics  
**semester.position:** 2.1  

**goals**

The aim of the course Mathematics 2 is to introduce students to basics of the following topics: Indefinite and definite integrals and their applications, differential calculus of real-valued multi-variable functions (which depend on several independent real variables), first-order differential equations.

**learning outcomes**

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

1) Solve indefinite, definite, and improper integrals of real valued functions of a real variable.

2) By applying learned techniques of integral calculus:  
   to calculate areas in the plane,  
   to calculate arc length,  
   to calculate area and volume by rotating an area.

3) Calculate partial derivatives - differentiation of the real-valued and vector-valued functions that takes more independent real variables.

4) By applying learned techniques of differentiation calculus:  
   to find extrema of real valued functions with more independent real variables  
   to investigate areas defined as hodograph of vector valued functions by application of fractional differentiation  

6) By application of learned technique for solving differential equations of first order:  
   to determine equations of orthogonal and isogonal trajectories to family of one parameter straight lines

**theoretical teaching**

transcendental functions, definite integral, definition,  
existence, basic properties, basic theorem of integral calculus,  
methods of integration of definite integral, improper integrals,  
quadrature of plane figure, cubature of solid of revolution,  
rectification of curve, surface of solid of revolution,  
differential calculus of real-valued multi-variable functions
(which depend on several independent real variables), Taylor’s theorem, local extreme values of a function with two independent variables, surface as hodograph of a vector-function depends on two independent variables, tangent plane and normal to surface, first-order differential equations, the method of separation of variables, first-order homogenous differential equations, first-order linear and Bernoulli differential equations, exact differential equations, integration factor, orthogonal and isogonal trajectories.

**practical teaching**

transcendental functions, definite integral, definition, existence, basic properties, basic theorem of integral calculus, methods of integration of definite integral, improper integrals, quadrature of plane figure, cubature of solid of revolution, rectification of curve, surface of solid of revolution, differential calculus of real-valued multi-variable functions (which depend on several independent real variables), Taylor’s theorem, local extreme values of a function with two independent variables, surface as hodograph of a vector-function depends on two independent variables, tangent plane and normal to surface, first-order differential equations, the method of separation of variables, first-order homogenous differential equations, first-order linear and Bernoulli differential equations, exact differential equations, integration factor, orthogonal and isogonal trajectories.

**prerequisite**

The course attendance condition is determined by the curriculum of study program.

**learning resources**

Written handouts from lectures in Mathematics 2: Lesson 1, Lesson 2, Lesson 3, Lesson 4, Lesson 5, Lesson 6, Lesson 7, Lesson 8, Lesson 9.

All the necessary literature is on:
http://147.91.27.133 or ftp://147.91.27.133

**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: 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

Д. Тошић, М. Албијанић, Д. Миленковић, Елементи диференцијалног и интегралног рачуна, Службени гласник, Београд 2012
С. Нешић: Збирка задатака из математике 1, Машички факултет, Београд, 1995
З. Мамузић, Б. Ђерасимовић, В. Симоновић: Основи математичке анализе са елементима диференцијалне геометрије и рачунарства, Научна књига, Београд, 1991
С. Нешић, Р. Радовановић: Збирка задатака из математике 2, Машички факултет, Београд, 1990.;
Миодраг М. Спалевић, Иван Д. Аранђеловић, Драган Ј. Додер, Александар В. Пејчев, Душан Љ. Ђукић. Јелена Д. Томановић: Диференцијалне једначине, Машички факултет Београд 2017
Mathematics 3

ID: MSc-0672
responsible/holder professor: Spalević M. Miodrag
teaching professor/s: Arandelović D. Ivan, Jandrlić R. Davorka, Pejčev V. Aleksandar, Radojević LJ. Slobodan, Spalević M. Miodrag, Cvetković S. Aleksandar
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written
parent department: mathematics
semester.position: 3.1

goals

The aim of the course Mathematics 3 is to introduce students to basics of the following topics: Linear differential equations of higher order, linear systems of differential equations, path and line integrals, multiple integrals, scalar and vector fields.

learning outcomes

Upon successful completion of this course, students should be able to:
• Identify and solve certain types of differential equations of higher order, in particular linear differential equations of higher order, solve systems of linear differential equations.
• Determine the frontiers of curves, surfaces and bodies in the plane and space, over which will be carried out the integration of functions of several variables.
• Determine all types of curvilinear, double, triple and surface integrals, both directly and by corresponding substitutions, and using known formulas, by which is easier to calculate.
• Apply lessons learned, and determine derivative in a given direction and the gradient of a scalar field, vector lines, divergence and curl of a vector field, the work and the flow of the vector field, and to carry out the classification of vector fields, determine the length of curves, measure of the surface area, volume of the body.

theoretical teaching

Linear differential equations of higher order, linear systems of differential equations, path and line integrals with applications, double integrals (definition, properties, evaluation, change of variables in double integrals), application of double integrals in computing solid volumes and surface areas, Green's theorem, triple integrals (definition, properties, evaluation, change of variables), improper double and triple integrals, surface integrals (definition, properties, evaluation, Stokes' and Gauss-Ostrogradsky theorems, path independence of line integrals, scalar and vector fields, gradient of a scalar field, vector lines, divergence and curl of a vector field, work and flow of a vector field, classification of vector fields.

practical teaching

Linear differential equations of higher order, linear systems of differential equations, path and line integrals with applications, double integrals (definition, properties, evaluation, change of variables in double integrals), application of double integrals in computing solid volumes and surface areas, Green's theorem, triple integrals (definition, properties, evaluation, change of variables), improper double and triple integrals, surface integrals (definition, properties, evaluation, Stokes' and Gauss-Ostrogradsky theorems, path independence of line integrals, scalar and vector fields, gradient of a scalar field, vector lines, divergence and curl of a vector field, work and flow of a vector field, classification of vector fields.
prerequisite

The course attendance conditions is determined by the curriculum of study program.

learning resources

Written handouts from lectures in Mathematics 3: Lesson 1, Lesson 2, Lesson 3, Lesson 4, Lesson 5, Lesson 6, Lesson 7, Lesson 8, Lesson 9.

M. Spalevic, A. Cvetkovic, I. Arandjelovic, A. Pejcev, D. Djukic, J. Tomanovic: Multiple, curvilinear, surface integrals and applications, series theory, 2015, Faculty of Mechanical Engineering Beograd. (The textbook in Serbian.)


number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 45

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: 0
final exam: 0

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): 35

references

Numerical methods

ID: MSc-0673  
**responsible/holder professor:** Cvetković S. Aleksandar  
**teaching professor/s:** Pejčev V. Aleksandar, Spalević M. Miodrag, Cvetković S. Aleksandar  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** mathematics  
**semester.position:** 5.2

**goals**

The main goal of this subject is to introduce the students with the basics of the numerical and functional series theory and the theory of numerical computation, as well as to demonstrate some implementation of the numerical methods in Matlab.

**learning outcomes**

After finishing the coursework, students are capable of
- understand convergence of numerical and functional series, methods of approximation using power series
- computing solutions of linear and nonlinear equations, interpolation problem, and ordinary differential equations, in general and using Matlab
- computing approximate values of integrals and derivatives, in general and using Matlab
- estimating the accuracy and precision of the computation.

**theoretical teaching**


Convergence analysis and order of the iterative method.


**practical teaching**


**prerequisite**

No prerequisites.

**learning resources**

Literature:
A.S. Cvetković, M.M. Spalević, Numerical methods, Faculty of Mechanical Engineering, University of Belgrade, 2013.

Software:
Matlab.

**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): 21

**references**

Biomechanics of locomotor system

ID: MSc-0800

responsible/holder professor: Lazarević P. Mihailo

level of studies: B.Sc. (undergraduate) academic studies

ECTS credits: 4

final exam: oral

parent department: mechanics

level: 5.5

goals

To introduce students to the application of fundamental principles and laws of biomechanics to understand and study human locomotor system (HLS) - prediction of functional motion / movement, human posture. The formation of the corresponding models of HLS, the possibility of simulations based on them in order to confirm the experimental data, its application to rehabilitation purposes. It allows the potential cooperation with experts in medicine, sports, etc. or work in specialized clinical institutions.

learning outcomes

• Applying the basic principles and laws of mechanics/biomechanics in order to understand and study human locomotion system (HLS)
• Determine anthropometric values of HLS
• Identify the most significant biomechanical properties of muscles, bones, ligaments, tendons, lung, cardiovascular system
• Forming biomechanical muscle models (Hill's muscle model, ...)
• Forming simpler kinematical/dynamical biomechanics models HLS, during (standing), walking, running,
• Numerical simulate the previously formed biomechanical models using programming environment (MATLAB, etc.)
• Analyzing energy aspects of HLS
• Choose the appropriate hip endoprosthesis on the previously conducted biomechanical analysis

theoretical teaching

practical teaching

Examples of determining anthropometric data. Models of muscle: skeletal, smooth, cardiac, bone models, the spinal column. Examples of solving the problems of kinematics and dynamics of the HLS. Energy analysis and stress analysis: various examples. Example of the cardiovascular, nervous and respiratory systems. Examples of biomechanical models of organs. Instances of models of HLS in the form of kinematic chains—different cases. Mathematical modeling of human body motion and interaction with the environment. Examples of locomotor motion: walking, running, sports movements. Computer methods and techniques in biomechanics (FEM, Matlab, ...) with the appropriate application. Biomedical measurements, instrumentation and equipment. Examples of models of prosthetic/orthotic mechanisms of applications in rehabilitation. Various problems of HLS.

prerequisite

desirable courses: Mechanics 1, Mechanics 2, Mechanics 3, Fundamentals of biomedical engineering, Human anatomy and physiology

learning resources

[6] Written abstracts from the lectures (Handouts)
[7] Cyberbotics Webots - software simulation package
[8] MATLAB, CATIA, software packages (CSP, SSO)

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

Mechanics 1

ID: MSc-0001

**responsible/holder professor:** Mladenović S. Nikola

**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:** B.Sc. (undergraduate) academic studies

**ECTS credits:** 6

**final exam:** oral

**parent department:** mechanics

**semester.position:** 1.2

**goals**

-to provide students knowledge of the fundamental principles of Statics
-to enable students to master the reduction of system to the simple form and determining conditions of equilibrium of the force system
-to prepare students for solving the problems in different engineering and scientific fields

**learning outcomes**

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

- Apply the principle of liberation from constraints of constrained body exposed to action of forces
- Form conditions of equilibrium and determine unknown forces in case of concurrent forces system
- Set conditions of equilibrium and determine unknown forces and torques in case of forces system in plane and in space and couples system
- Determine basic static quantities (normal-force, shear-force and bending-moment) in a cross-section of beams and frames as well as depict their diagram
- Solve static problems regarded to sliding friction and rolling friction
- Determine center of gravity of a body

**theoretical teaching**


**practical teaching**


prerequisite

no

learning resources

[3] 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

Mechanics 2

ID: MSc-1172

responsible/holder professor: Jeremić M. Olivera

level of studies: B.Sc. (undergraduate) academic studies

ECTS credits: 6

final exam: oral

parent department: mechanics

semester.position: 3.2

goals

-to provide students knowledge of the fundamental principles of Kinematics and Particle Dynamics
-to enable students to master the determination of motion, properties of motion of mechanical objects and determination the causes of motions
-to prepare students for solving the problems in different engineering and scientific fields

learning outcomes

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

• Analyze motion of a particle in various coordinate systems
• Solve problems related to kinematics of a particle, i.e. to determine line of motion, trajectory, velocity, acceleration and sector velocity
• Describe certain types of body motion: translation, rotation of a body about a fixed line, plane motion, spherical motion and general motion of a rigid body, as well as to determine kinematic quantities of a body (angular velocity and angular acceleration) and to determine velocity and acceleration of some points of a body
• Solve kinematic problems related to the relative motion of a particle
• Set differential equation related to the motion of a free and constrained particle, as well as to solve direct and inverse dynamic problem of a particle
• Determine center of mass and inertia moments of a particle system and a rigid body

theoretical teaching


practical teaching

Determination of Motion of Particle – Vector and Natural. Determination of Particle Velocity in Various Types of Coordinate Systems. Determination of Particle Acceleration. Translation.

**prerequisite**

Defined by curriculum.

**learning resources**

[6] 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

Rusov, L., Kinematics, Naučna knjiga, 1983.
Đurić, S., Kinematics, Faculty of Mechanical Engineering, Belgrade, 1990.
Mechanics 3

**ID:** MSc-0799  
**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:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** mechanics  
**semester.position:** 4.2

**goals**

-to provide students knowledge of the fundamental principles of Particle Dynamics and Mechanical System Dynamics  
-to enable students to master the basic theorems and laws of Mechanical System Dynamics, basic concepts of linear vibration of a particle and elements of Analytical Mechanics  
-to prepare students for solving the problems in different engineering and scientific fields

**learning outcomes**

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

- Form expressions for momentum and angular momentum of a particle, a system of particles and a rigid body  
- Determine kinetic energy of a particle, a system of particles and a rigid body  
- Apply impulse-linear momentum theorem, angular impulse-angular momentum theorem and work-kinetic energy theorem of a particle, a system of particles and a rigid body  
- Solve motion problems of a particle under central force  
- Solve problems of linear straight line vibrations of a particle  
- Analyze dynamics of relative motion of a particle  
- Form differential equations and solve direct or inverse dynamic problem for translation, for rotation about fixed axe and for planar motion of rigid body  
- Apply general equation of statics, general equation of dynamics and Lagrange equations of the first kind on rigid bodies systems

**theoretical teaching**

practical teaching


prerequisite

Defined by the curriculum study 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
Đurić, S., Dynamics and theory of Vibrations, Faculty of Mechanical Engineering, Belgrade, 1987.
Theory of Mechanical Vibrations

ID: MSc-0012
responsible/holder professor: Obradović M. Aleksandar
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: oral
parent department: mechanics
semester.position: 6.4

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**

The subject can take students who have made a condition for entry into the third year of study.

**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

Fundamentals of Motor Vehicles

ID: MSc-0869

responsible/holder professor: Mitić R. Saša

teaching professor/s: Blagojević A. Ivan, Mitić R. Saša

level of studies: B.Sc. (undergraduate) academic studies

ECTS credits: 6

final exam: written+oral

parent department: motor vehicles

semester.position: 3.5

goals

Aims of this course include achieving of competences for conquering the basic specific knowledge and skills needed for overviewing and understanding of problems of motor vehicles, their functioning, basic systems, as well as vehicle`s drag and dynamic characteristics in particular environment conditions.

learning outcomes

After successful completion of this course, students should be trained to:
- Recognize basic categories and characteristics of vehicles;
- Review and analyze the characteristics of vehicle systems and components;
- Explain vehicle design concept and analyze existing concepts;
- Define and explain forces acting on a vehicle in motion;
- Describe force distribution in tyre–surface contact;
- Identify characteristic parameters needed to determine adhesion, sliding and rolling resistance;
- Recognize modern vehicle electronic systems and to assess their influence on traffic safety.

theoretical teaching

Introduction: (1) Basic terms, vehicle performance, vehicle classification and categorization, vehicle homologation; (2) Concepts of vehicle design, basic systems and elements; (3) Transmission system: construction, tasks and way of functioning – clutch, gearbox, transfer case; (4) Transmission system: construction, tasks and way of functioning – drive axle, final drive, wheels; (5) Characteristic vehicle systems: suspension and steering system, braking system, support structure; (6) Vehicle propulsion: forces in wheel – surface contact, adhesion coefficient, slip coefficient, determination of reactive forces, power transfer from engine to wheels; (7) Passenger and freight vehicles: maximum performances, drag diagram, power characteristics, power balance, acceleration and braking, vehicle stability; (8) Work vehicles: drag diagram, power balance, total efficiency coefficient; (9) Vehicle safety: safety parameters, ecological aspects, mechatronic systems on vehicle (ABS, ASR, ESP...); (10) Vehicle testing: basic aspects of vehicle testing and verification, as well as of their systems and components.

practical teaching

Review of basic vehicle classification and categorization; comments on vehicle homologation; basics of vehicle design concepts; engine; (2) Transmission system – clutch, gearbox, transfer case, driving axle (review of characteristic examples); (3) Basic vehicle systes – wheels, suspension and steering, braking (review of characteristic examples); (4) View of characteristic examples on specific schemes and on real models; (5) View of testing and
verification of characteristic systems and components problems.

**prerequisite**

No special requirements.

**learning resources**


3. Handouts

4. Laboratory for Motor Vehicles, Institute for Motor Vehicles.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 23
laboratory exercises: 5
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: 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): 36

references

Skill Praxis B - MOV

**ID:** MSc-1223

**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:** B.Sc. (undergraduate) academic studies

**ECTS credits:** 1

**final exam:** seminar works

**parent department:** motor vehicles

**semester.position:** 4.5

**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.
Vehicle Design 1

ID: MSc-0540

responsible/holder professor: Aleksendrić S. Dragan

teaching professor/s: Aleksendrić S. Dragan

level of studies: B.Sc. (undergraduate) academic studies

ECTS credits: 6

final exam: written

parent department: motor vehicles

semester.position: 6.4

goals

Vehicle Design is a complex process, concerned with powertrain, aerodynamics, environmental impact, ergonomics, legislation, materials, production, safety and technology. Course objective is to provide an understanding of the design process of motor vehicles regarding: a) basic requirements being imposed to vehicle and its systems, assemblies, sub-assemblies, and parts, b) influences of vehicle components design on its overall performance, time and cost development, quality of use, and recycling process c) legislation related to the specific vehicle categories. This course aims to develop the broad range of students’ skills and knowledge to be able to understand, recognize, and solve complex issues in a vehicle design as a part of challenging automotive industry.

learning outcomes

Course outcomes are development of student’s abilities to: a) understand the process of a vehicle design, its relation to design of vehicle systems as well as to be able to design the process to meet desired vehicle/systems characteristics, b) be aware of contemporary issues in vehicle design, c) be able to access various technical information sources, d) be able to function in the team, e) identify key issues, formulate and apply technical knowledge to solve engineering problems related to vehicle design, f) develop written and oral communication skills, g) understand how to use the techniques, skills and modern engineering tools for resolving the problems related to a vehicle design.

theoretical teaching

Theoretical lectures are divided into 13 sections: 1) Introduction – a vehicle design and automotive engineering, 2) New materials and vehicle design, 3) Vehicle design and its production, 4) Vehicle construction and its design, 5) Vehicle design from the point of power sources, 6) Vehicle design and power transmission system (friction clutch, manual and automatic gearboxes, drive shaft, final drive transmission and differentials), 7) Vehicle design from the point of braking system, 8) Vehicle design from the point of suspension system, 9) Vehicle design from the point of aerodynamics, 10) Vehicle design from the point of steering system, 11) Vehicle design from the point of ergonomics, 12) Vehicle design from the point of wheels – tires, 13) Vehicle design from the point of its safety.

practical teaching

Students carry out a group-engineering project. Project is related to critical analysis of design solutions of the given vehicle and its systems. Students have to collect, analysis, synthesis, and present technical information about the design of the given vehicle with aim to understand influence of real design solutions on the vehicle performance and to propose possible improvements of the vehicle design.
prerequisite

There is no precondition.

learning resources

D. Aleksendrić: Vehicle Design 1, Handouts, Faculty of Mechanical Engineering, Belgrade, 2010, DBL.
National and international standards, UN/ECE Regulations, EC Directives, related to motor vehicles.

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: 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

Vehicle Dynamics

**ID:** MSc-0871  
**responsible/holder professor:** Mitić R. Saša  
**teaching professor/s:** Mitić R. Saša, Rakićević B. Branislav  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** motor vehicles  
**semester.position:** 5.4

**goals**

Aims of this course are offering of overall insight in problems of vehicle dynamics, firstly in specific items of wheel – surface contact. This course is intended for the students of Motor Vehicle Module, and represent an introduction for the further exploration of theory of vehicle dynamics. Students are also getting knowledge about incorporating of engine, transmission and driving characteristics into one unit, which is the base for all future activities within the Module.

**learning outcomes**

After successful completion of this course, students should be trained to:
- List, define and explain forces acting on a vehicle in motion;
- Explain and analyze force distribution in tyre–surface contact;
- Analyze characteristic parameters needed to determine grip, friction, sliding and rolling resistance;
- Discuss and give graphic interpretation of tractive force diagram of the vehicle for defined conditions;
- Explain the influence of transmission parameters on vehicle performance;
- Select transmission elements corresponded to engine performance and road conditions;
- Apply tractive force analysis on transport vehicles and machinery;
- Analyze and explain the consequences of all-wheel drive powertrain related to power circulation.

**theoretical teaching**

Basic terms – vehicle as dynamic system; forces, momentums, reactive forces; wheel and surface characteristics; forces acting on vehicle – static and dynamic reactive forces – vertical, tractive and side forces; maximum performances – speed, acceleration and slope; engine – characteristics of engines, diagram, transferring of engine characteristics from engine to wheels; equation of movement; dynamic characteristics of passenger, freighth and work vehicles – drag diagram, power characteristics, power balance, gear ratios, theoretical and real speed of work vehicles, slip coefficient.

**practical teaching**

Practical lessons are made through public exercise, as preparation for individual students’ papers and through practicing some calculations related to all matters studied already in theoretical part. Also, there are autonomous activities of students in calculations within specific areas of course, as well as creation of individual papers, that represent implementation of achieved knowledge for making a dynamic characteristics of vehicles. There is possibility for consultation with teachers, which is preparation for tests and final
exam.

prerequisite
No special requirements.

learning resources


number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 4
laboratory exercises: 0
calculation tasks: 19
seminar works: 5
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: 0
check and assessment of seminar works: 3
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: 20
seminar works: 20
project design: 0
final exam: 30
requirements to take the exam (number of points): 40

references

Thomas D. Gillespie: Fundamentals of Vehicle Dynamics, SAE.
**Vehicles Safety**

**ID:** MSc-0504  
**responsible/holder professor:** Rakićević B. Branislav  
**teaching professor/s:** Aleksendrić S. Dragan, Blagojević A. Ivan, Mitić R. Saša, Rakićević B. Branislav  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** motor vehicles  
**semester.position:** 5.5

**goals**

Course objectives are to provide knowledge, skills, and competencies relating to safety-related vehicle systems and fundamental understanding of their operation and performance. Students should be able to understand and solve complex engineering issues in order to increase motor vehicle safety as the most important requirement imposed to automotive industry.

**learning outcomes**

After successful completion of this course, students should be trained to:
- Explain synergetic influences of systems responsible for vehicle safety on parameters of active, passive and catalytic safety of motor vehicles;
- Analyze the functioning of safety systems on vehicles related to insufficiently determined operating conditions, and possible driver confusion while systems work;
- Analyze safety systems limits and their influence on a driver, vehicle and traffic;
- Solve different case study problems related to vehicle safety;
- Explain force distribution in tyre–surface contact, as well as physical limits of this forces responsible for vehicle movement and behaviour.

**theoretical teaching**

(1) Introduction (terms and definitions); System driver – vehicle – environment (road); Intelligent traffic solutions; (2) Vehicle safety as a part of traffic safety; (3) Requirements imposed to motor vehicles from the driver and environment point of view; (4) Influencing parameters on motor vehicles safety; (5) Concept, mission, tasks, operation, and performance of safety related vehicle systems; (6) Vehicle stability versus an interaction and load distribution between wheels and road surfaces during braking, driving, and steering in different driving situations; (7) Ecological aspects of vehicle safety; (8) Advanced driver assistance systems and motor vehicle safety; (9) Mechatronic solutions for safety-related motor vehicle systems; (10) Regulations and directives in motor vehicles safety.

**practical teaching**

(1) Introduction to a project; (2) Project related to critical analyses of safety aspects of motor vehicles with the aim to collect, analyse, synthesise, and present technical information about active and/or passive and/or catalytic safety of the given vehicle; (3) Calculation tasks related to forces in wheel–surface contact and vehicle stability during braking, driving and turning; (4) Analysis of characteristic examples related to implementation of electronically controlled systems on vehicles; (5) Ecological aspects of vehicle safety; (6) Analysis of regulation and directives related to vehicle safety; (7) Guidelines and instructions for regulations related to...
safety of special purpose vehicles (ADR – vehicles intended for transport of dangerous goods...). (8) Visit and demonstration of check procedure of vehicle safety at station for periodical technical inspection.

prerequisite

No special requirements.

learning resources

3, National and international standards, UN Regulations, EC Directives, related to motor vehicles safety
4, Handouts
5, Technical documentation from leading world manufacturers

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: 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: 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

Vehicle systems

**ID:** MSc-1029  
**responsible/holder professor:** Aleksendrić S. Dragan  
**teaching professor/s:** Aleksendrić S. Dragan, Blagojević A. Ivan  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** motor vehicles  
**semester.position:** 4.4

**goals**

Course objectives are to provide a comprehensive insight into the construction of motor vehicles. Providing knowledge related to constructive characteristics of systems, assemblies, and parts of motor vehicles as well as principles of their operation. Students should be able to understand the basic principles of motor vehicle systems operation, their primary tasks, and influence of solutions in the construction of motor vehicle systems on its overall behaviour.

**learning outcomes**

Course outcomes are development of student’s abilities to understand construction of motor vehicles, the role, characteristics, and principles of motor vehicle systems operation. Critical analysis of operation of motor vehicles systems as well as ability to identify the influence of constructive characteristics of a motor vehicle systems, assemblies, and parts on its overall functional characteristic as a whole.

**theoretical teaching**

Introduction – general about motor vehicles (classification, categorization, unification, and standardization).  
Vehicles construction and propulsion; Power transmission systems (friction clutch, manual and automatic gearboxes, drive shaft, final drive transmission and differentials); Braking system; Tiers, Suspension and steering system; Vehicle body; Electronically controlled systems.

**practical teaching**

Practical exercises are organized through auditoral explanation and students work in laboratory. Laboratory work is designed to provide students with possibilities to be practically familiarized with each system of motor vehicle as well as its constructive characteristics and principles of operation.

**prerequisite**

There is no precondition.

**learning resources**

D. Aleksendrić. Vehicle systems, Handouts, Faculty of Mechanical Engineering, Belgrade,
2016, DBL.
I. Blagojevic. Vehicle systems, Handouts, Faculty of Mechanical Engineering, Belgrade, 2016, DBL.

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: 10
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): 0

references

H. Heisler, Advanced Vehicle Technology, Butterworth – Heinemann, 2002
Buoyancy and Stability of Ship 1

ID: MSc-0693
responsible/holder professor: Baćkalov A. Igor
teaching professor/s: Baćkalov A. Igor
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: naval systems
semester.position: 5.4

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) /In Serbian/
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
Ship equipment

ID: MSc-0954  
responsible/holder professor: Simić P. Aleksandar  
teaching professor/s: Simić P. Aleksandar  
level of studies: B.Sc. (undergraduate) academic studies  
ECTS credits: 2  
final exam: written  
parent department: naval systems  
semester.position: 6.4

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

Ship Structures 1

ID: MSc-0071  
**responsible/holder professor:** Motok D. Milorad  
**teaching professor/s:** Momčilović V. Nikola, Motok D. Milorad  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** naval systems  
**semester.position:** 5.5

**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.
Ship systems

ID: MSc-1013  
responsible/holder professor: Kalajdžić D. Milan  
teaching professor/s: Kalajdžić D. Milan  
level of studies: B.Sc. (undergraduate) academic studies  
ECTS credits: 4  
final exam: written+oral  
parent department: naval systems  
semester.position: 6.4

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

The second study year completed. Semester 5 enrolled.

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
Skill Praxis B - BRO

ID: MSc-1219
**responsible/holder professor:** Kalajdžić D. Milan
**teaching professor/s:** Kalajdžić D. Milan
**level of studies:** B.Sc. (undergraduate) academic studies
**ECTS credits:** 1
**final exam:** seminar works
**parent department:** naval systems
**semester.position:** 4.5

**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
Electrical engineering

ID: MSc-1070
responsible/holder professor: Škatarić M. Dobrila
teaching professor/s: Lukić M. Petar, Stojić M. Tomislav, Škatarić M. Dobrila
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: physics and electrical engineering
semester.position: 6.1

goals

The aim of the course is to familiarize the students with basic laws of electrical engineering and to develop their competence for acquisition of more advanced academic knowledge and skills in scientific, professional and applied areas of mechanical engineering relying on electrical engineering. The students are introduced into basic phenomena, devices and circuits encountered in electrical engineering, and methods for their analysis and basic measurements.

learning outcomes

Upon successful completion of this course student should be able to:
1. theoretically and mathematically describe and incorporate basic concepts, laws, relations and processes of general electrical engineering, i.e., area of electrostatic, electrokinetics, electromagnetism and alternating (sinusoidal) currents;
2. mathematically adequately describe expresses and coupling the various electrical, magnetic, and other physical quantities required for basic engineering modeling of different phenomena and processes in electrical engineering;
3. theoretically and mathematically describe and link the basic concepts in the field of electrical measurements;
4. analyze and engineeringly display the results of direct and indirect laboratory measurements.
5. recognize the connection of mechanical, hydraulic and thermal systems with analogue electrical systems.

Checking of outcomes referred to in points 1), 2), 3) and 5) is carried out through the questions on tests, colloquiums and final exam, or checking student responses to questions. Outcome point 4) is checked by an individual laboratory exercises and the defense of student reports made after the laboratory exercises.

theoretical teaching

Electrostatic (brief historical overview, electrical load, Coulomb's law, electric field, potential and voltage, conductors in an electric field, Gauss's law with applications, dipoles, polarization of dielectrics, capacitors: capacitance, type and application, energy of the electric field); Direct current (current field and its characterization, electrolysis, continuity equation and Kirchhoff's laws, Ohm's law, Joule's law, resistors, ems (electromotive force): its origin and type, electric generators: characteristics and transformation, electric circuits and networks, work and power, basic theorems of electrical circuits); Electromagnetism (magnetic field, basic quantities and laws, concept of magnetic flux and conservation law, Ampere's law on the circulation of the vector of magnetic induction, the materials in the
magnetic field, magnetisation field and total current law, the magnetic circuits, electromagnetic induction, inductance coefficients, energy of magnetic field, electromechanical conversion; Alternating (sinusoidal) current (generation, characterization, phasor's approach, power, network analysis methods in steady sinusoidal state); Three-phase circuits.

**practical teaching**

The selected problems will be solved on auditory exercises. Six laboratory exercises are scheduled: 1. Introduction to basic electrical measuring instruments and principles of their operation. Practical application. 2. Basic measuring in DC circuits: current, voltage, power and resistance. 3. Demonstration of basic electromagnetic's laws and proofing of them by measuring. 4. Basic measuring in AC single phase circuits: current, voltage, power, inductance, capacitance and resistance. 5. Three phase power measurements. 6. Advanced techniques in electrical measuring: digital and computer based measurements.

**prerequisite**

No specific conditions

**learning resources**


**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 22
laboratory exercises: 6
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: 0
check and assessment of projects: 0
colloquium, with assessment: 9
test, with assessment: 0
final exam: 3

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

Del Toro V., Electrical Engineering Fundamentals, Prentice-Hall, New Jersey, 1986;
Electronics

ID: MSc-1071
responsible/holder professor: Lukić M. Petar
teaching professor/s: Lukić M. Petar, Stojić M. Tomislav
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: physics and electrical engineering
semester.position: 6.3

goals

Understanding the fundamental laws of the Electronics and the attainment of competencies for the further development of the academic knowledge and skills in scientific, professional and applied engineering areas and mechanical engineering that rely on Electronics.
Understanding the fundamental components and circuits that are used in Electronics and methods for their analysis, simulation and design.

learning outcomes

Staying in the program, students acquire the ability to carry out scientific and technical activities. Mastered the methods of analysis, measurements and design, predictions and solutions consideration of consequences. Acquire an understanding of research and practical methods in the field of electronics that would adequately be able to apply in resolving concrete problems in mechanical engineering.

theoretical teaching

Place and Role of Electronics; object of study; a brief history; electronic components and electronic circuits - some basic share; signals in electronic circuits. Fundamentals of semiconductor physics: structure of crystals, pure and doped semiconductors, electrical properties, transport processes; p-n junction: directly and inversely polarized. Semiconductor diodes: structure, role and working principle, static and approximate static characteristics, models for small and large signals, temperature effects, polarization, specific types of diodes. Bipolar transistors: structure, roles and working principle, static characteristics, polarization, models for large and small signals, Darlington configuration. Unipolar transistors - FETs, JFET and MOSFET: structure and functioning, role and working principle, static characteristics, polarization, models for large and small signals, SiC and heterostructure based transistors. Basic circuits with diodes: half-wave and full-wave rectifiers, diode clipping and clamping circuits. Basic amplifier configurations, types and specifications, common emitter, common base and common collector amplifiers, operation analysis. Current sources: current mirror, Wilson and Widlar current source. Two-stage and multi-stage amplifiers, the designe principles and operation analysis. Negative feedback: concept, role and types; amplifier with negative feedback amplification and its impact on the characteristics of amplifiers, design principles. Circuits with operational amplifier: operational, differential, inverting, non-inverting amplifier, differentiator, integrator, voltage to current and current to voltage converters, precision rectifiers. Complex circuits - design principles. Linear oscillators roles and types, operation principles, the condition of oscillation, Wien bridge oscillator, Hartley and Colpitts oscillator.

practical teaching
For auditory exercises are being selected numerical examples that follow the curriculum of lectures. Special attention is paid to the analysis of the work of individual electronic circuits, the roles of the individual components in circuits, reviewing of electronic circuits as functional units, but also recognizing the individual characteristic assemblies inside the circuit. The starting point is the easiest circuits, and then tends that students independently, combining smaller units, designed more complex circuits. There is a possibility of laboratory exercises: basic applications of diodes (rectifiers, limiters); common emitter amplifier (adjusting setpoints and recording frequency characteristics); selected circuits with operational amplifiers.

prerequisite
Defined by study program curriculum.

learning resources

8. Handouts

number of hours

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
check and assessment of projects: 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: 0
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 35
requirements to take the exam (number of points): 30

**references**

Electronics and biomedical measurements

ID: MSc-1072  
responsible/holder professor: Stojić M. Tomislav  
teaching professor/s: Lukić M. Petar, Stojić M. Tomislav  
level of studies: B.Sc. (undergraduate) academic studies  
ECTS credits: 6  
final exam: written+oral  
parent department: physics and electrical engineering  
semester.position: 6.3

goals

Introducing to fundamentals of Electronics, the most common electronic components and circuits. Presentation of the basic medical measurements and diagnostics methods. The focus is on the operation of standard biomedical equipment with brief description of device construction. The subject educates engineers to improve still existing and develop new biomedical devices.

learning outcomes

Student should be able to:

1. understand and analyze the problems of functioning and using basic biomedical instrumentation and equipment;
2. theoretical and mathematical adequately describe and interconnect basic concepts, laws, relations and processes that deal with analog and digital electronics;
3. apply the knowledge of concepts, laws, relations and processes prevailing in electronics and electronic circuits, in analyzing and solving basic and fundamental engineering problems in biomedicine;
4. apply theoretical knowledge in the field of electronics and analysis of electronic circuits in basic biomedical measurements in the laboratory and in the simulation on the computer;

Examination of outcomes referred to in points 1), 2) and 3) is carried out through the questions on tests, colloquiums and final exam, or checking of student responses to questions. The outcome of point 4) is checked by an independent laboratory exercises of the students.

theoretical teaching


practical teaching


**prerequisite**

Defined by the curriculum of the study program - module.

**learning resources**


[4] Printed excerpts 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: 5
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: 5
test/colloquium: 50
laboratory exercises: 0
calculation tasks: 0
seminar works: 10
project design: 0
final exam: 35
requirements to take the exam (number of points): 35

references

Physics and Measurements

**ID:** MSc-0025  
**responsible/holder professor:** Vasić-Milovanović I. Aleksandra  
**teaching professor/s:** Vasić-Milovanović I. Aleksandra, Ilić T. Jelena, Jovanović V. Jasmina, Pavlović P. Vera, Trifković M. Zoran  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** physics and electrical engineering  
**semester.position:** 1.4

**goals**

Understanding of basic physical concepts and laws. Aspects of practical application of these laws. Development of problem solving skills through examples from engineering practice and everyday life by applying basic physics laws. Introduction to main devices and methods of direct and indirect measurements in physics and techniques. Understanding of contemporary methods for measurement result processing.

**learning outcomes**

Final outcomes:  
1) adequate theoretical and mathematical description and interconnection of processes in general physics,  
2) adequate mathematical description of physical properties,  
3) application of physical laws, relations and processes in solving basic technical problems,  
4) theoretical and mathematical description of basic concepts in theory of measurements,  
5) application of acquired theoretical knowledge of physics and measurements for laboratory practice,  
6) analytical and scientific representation of measurement results in laboratory exercises.

**theoretical teaching**


**practical teaching**

Examples of determination of trajectory, path, velocity and acceleration of the body for motions along a straight and curved line. Application of Newton's second law and conservation of mechanical energy for different types of motion, especially for oscillations. Considering the changes in the system energy under the influence of conservative and nonconservative forces and determination of performed work. Application of conservation of momentum. Solving problems in the field of physics of ideal fluids and gases. Application of energy conservation for stationary flow of ideal fluids, as well as in thermophysics for determination of performed work during different thermodynamical processes. Examples in the field of propagation of transverse and longitudinal mechanical waves. Standing waves in

**prerequisite**

Defined by the 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: 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: 0
check and assessment of lab reports: 3
check and assessment of seminar works: 0
check and assessment of projects: 0
colloquium, with assessment: 6
test, with assessment: 3
final exam: 3

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

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

Aničin Božidar, Lectures in Physics 1, Faculty of Mechanical Engineering, Belgrade, various editions.
Olga Žižić, Lectures in Physics 2, Faculty of Mechanical Engineering, Belgrade, various editions.
Olga Žižić, Physics - Collection of Solved Problems, Faculty of Mechanical Engineering, Belgrade, various editions.
Mechanical Design of Process Equipment

ID: MSc-0087
responsible/holder professor: Petrović LJ. Aleksandar
Teaching professor/s: Petrović LJ. Aleksandar
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: process and environmental protection engineering
semester.position: 5.4

goals

Objective of the course is that students acquire academic skills and academic competencies for selection and calculation of strength of high or low pressure vessels, apparatus and equipment. By performing students’ projects, they acquire creative and specific practical skills that qualify them to perform professional work in the field of process equipment design. Through the laboratory experiments and exercises, students gain knowledge of testing and exploiting process equipment.

learning outcomes

By successful completion of the study program student acquires the following skills: analysis, synthesis and prediction of solutions and consequences; development of critical thinking and self-critical approach; application of knowledge in practice; professional ethics; correlation of knowledge from different fields and their applications; development of skill and proficiency in the use of knowledge in field of process equipment.

theoretical teaching


practical teaching


prerequisite

Students enrolled in third year of bachelor studies; passed exams from the first year of studies.

learning resources

HANDOUTS,

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 20
laboratory exercises: 2
calculation tasks: 0
seminar works: 0
project design: 8
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: 5
test/colloquium: 20
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 50
requirements to take the exam (number of points): 30

**references**

Handouts
Pipeline and fittings

**ID:** MSc-0082  
**responsible/holder professor:** Petrović LJ. Aleksandar  
**teaching professor/s:** Petrović LJ. Aleksandar  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** process and environmental protection engineering  
**semester.position:** 6.3

**goals**

Objective of the course is that students acquire academic skills and academic competencies for selection and calculation of pipelines and pipeline fittings. By performing students’ projects, they acquire creative and specific practical skills that qualify them to perform professional work in the field of pipeline design. Through the laboratory experiments and exercises, students gain knowledge of testing and exploiting process equipment.

**learning outcomes**

By successful completion of the study program student acquires the following skills: analysis, synthesis and prediction of solutions and consequences; development of critical thinking and self-critical approach; application of knowledge in practice; professional ethics; correlation of knowledge from different fields and their applications; development of skill and proficiency in the use of knowledge in field of pipelines and pipeline fittings.

**theoretical teaching**

1. Classification and marking of pipelines; Input data for design; Description of activities in the design phase; Materials for pipelines; Graphical documentation. 2. Calculation of the thickness of pipe wall, pipe elbow and other fittings, plastic and elastic deformations, distribution of loads from the internal pressure; Flanges; Welding. 3. Safety equipment. Pipelines supports, Distance between supports, Pipeline testing. 4. Self-compensation, axial compensator, pipelines not laid in canals, selection and calculations. 5. Pipelines laid and not laid in canals, Systems of pipelines, pipeline systems not laid in canals. 6. Thermo-isolation and protection against corrosion. 7. Purpose and classification, plug valves (passing, three-way and four-way valves and ball valves) regulation characteristics. 8. Safety valves, safety valve’s calculation and selection. 9. Condensation and Moisture Separators, Filters, air release valve. 10. Valve functions, calculation and selection.

**practical teaching**

**prerequisite**

Students enrolled in second year of bachelor studies; passed exams from the first years of studies.

**learning resources**

HANDOUTS,

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 20
laboratory exercises: 2
calculation tasks: 0
seminar works: 0
project design: 8
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: 5
test/colloquium: 20
laboratory exercises: 5
calculation tasks: 0
seminar works: 0
project design: 20
final exam: 50
requirements to take the exam (number of points): 30

**references**
Handouts
CAD/CAM SYSTEMS

ID: MSc-0664
responsible/holder professor: Puzović M. Radovan
teaching professor/s: Mladenović M. Goran, Puzović M. Radovan
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written
parent department: production engineering
semester.position: 5.5

goals

1. Awareness that efficiency of computer use in engineering activities can be accomplished only through integrated systems, such as CAD/CAM systems used in the area of product design and design of manufacturing technology
2. Mastery of theoretical foundations of contemporary CAD/CAM systems structure and operation
3. Acquisition of practical knowledge about using CAD/CAM systems and numerically controlled machine tools programming

learning outcomes

On successful completion of the course, students should be able to:
• Design products using CAD (3D modeling of parts and assemblies).
• Design manufacturing technology of parts using CAD (creating NC-sequences).
• Identify the NC program contents (G-code) for CNC machine tools.
• Apply in practice some of the contemporary CAD/CAM systems for product and manufacturing technology design.
• Transfer NC program into a control unit of a respective CNC machine tool.

theoretical teaching

Theoretical teaching comprises two teaching units:
1. Problem of work-piece geometrical modeling as a basis of CAD system. Internal, computerized and model development of work-piece means to create prerequisites for using that model as a basis for design of manufacturing technology and for generating control information (CAM) for numerically controlled machine tool. In addition to using conventional numerical control technology, this teaching unit is also considering the application of work-piece computer model as a basis of "rapid prototyping" by material addition technology
2. Basis, structure and application of conventional languages for programming numerically controlled machines are presented. Studies of geometry description, kinematics, technological demands and post-processor commands lead to the contents and structure of control information for modern computer controlled machine tools. Syllabus also includes studying of APT and EXAPT languages

practical teaching

Exercises are organized in computer rooms and at the Laboratory for machine tools. Using available CAD/CAM software, such as ProEngineer, Autodesk Inventor, Catia, Solid Edge and...
the like, the student will master the skill of work-piece geometrical model development as well as the skill of generating tool path in making NC program for numerically controlled machine tools. Also, the student will write NC program in APT. Final exercise involves the development of NC program for a concrete work-piece on a concrete machining center. Work-piece is manufactured at the Laboratory for machine tools.

**prerequisite**

This course is strongly linked to the area of production engineering and there are no prerequisites for course attendance.

**learning resources**

Lectures in e-form [In Serbian]. Book: APT language (in serbian. Faculty for Mechanical Engineering), Instructions for performing laboratory exercises [In Serbian]. Instructions for project design [In Serbian]. CA workstation (CAD, CAM, CAE, CAPP, ...), CAD/CAM software package.

**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: 1
Check and assessment of seminar works: 0
Check and assessment of projects: 0
Colloquium, with assessment: 0
Test, with assessment: 9
Final exam: 5

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

Feedback during course study: 10
Test/Colloquium: 20
Laboratory exercises: 30
Calculation tasks: 0
Seminar works: 0
project design: 0
final exam: 40
requirements to take the exam (number of points): 40

**references**

Lectures in e-form [In Serbian].
Book: APT language (in serbian).
**Computer Graphics**

**ID:** MSc-0663  
**responsible/holder professor:** Jakovljević B. Živana  
**teaching professor/s:** Jakovljević B. Živana, Mladenović M. Goran  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** production engineering  
**semester.position:** 4.4

**goals**

The objective of this course is that students: obtain fundamental knowledge and skills necessary for advanced application of computer graphics in various engineering activities; master theoretical and mathematical basics of computer graphics; gain necessary knowledge, skills and practical experiences in development of software applications based on computer graphics; understand basic functional principles and acquire knowledge for advanced usage of computer aided design tools.

**learning outcomes**

After successfully completing this course, the students should be capable to:
- Apply basic and composite two-dimensional and three-dimensional graphical transformations in various engineering problems solving;
- Carry out the projection of objects on scene on projection plane;
- Generate free form lines and surfaces using Bezier curve and surface and B spline curve and surface;
- Apply clipping and hidden surfaces removal algorithms in various engineering problems solving;
- Generate photorealistic image in three dimensional graphics and animation.

**theoretical teaching**

1. Introduction to computer graphics: vector and raster graphics, color models, hardware components for image display  
2. Modeling in computer graphics: the role of modeling in graphics pipeline, camera model, coordinate systems in computer graphics, hierarchical modeling, B representation  
3. Two-dimensional transformations: translation, rotation, scaling, mirror reflection, order of transformations  
4. Three-dimensional transformations: translation, rotation, scaling, mirror reflection, order of transformations  
5. Projections: orthographic projection, axonometric projection, isometric projection, perspective, viewpoint transformation  
6. Curves and curved surfaces: Bezier curves, B spline, NURBS, Bezier surfaces, B spline surfaces  
7. Clipping: algorithms for clipping of points, lines polygons: three-dimensional clipping  
8. Visibility: Hidden faces removal  
9. Illumination and reflection: light sources, ambient light, diffuse reflection, specular reflection, atmospheric attenuation, shadows  
10. Shading: flat, Gouraud, Phong, ray tracing
practical teaching

During exercises student masters practical application of knowledge gained during lectures. Based on programming skills, student writes subroutines, which represent elementary building blocks of computer graphics. While testing programs, students revel the complexity of application of computer graphics as well as the principles of solving computer graphics problems. Finally, students are presented with commercial products based on computer graphics application and compare their own solutions with commercial.

prerequisite

Programming basics

learning resources

Jakovljevic Zivana, Computer Graphics, lecture handouts
Computer classroom – each student individually works on a computer
Matlab
Visual Studio 2010
Commercial CAD software

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 28
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: 1
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: 8
final exam: 5

assessment of knowledge (maximum number of points - 100)

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

references

Computer simulation and artificial intelligence

**ID:** MSc-0404  
**responsible/holder professor:** Babić R. Bojan  
**teaching professor/s:** Babić R. Bojan, Miljković D. Zoran, Petrović M. Milica  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** production engineering  
**semester.position:** 4.4

**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. Artificial intelligence will be understood through models, structure of intelligent agents and machine learning. By using of simulation and software tools students will get knowledge for application of artificial neural networks.

**learning outcomes**

After the course the students will be able to:
- develop models of manufacturing systems and other discrete systems,  
- implement model by using adequate simulation software,  
- verify built model,  
- evaluate and analyse simulation outputs and compare alternative solutions,  
- give suggestions for optimization of real system,  
- choose methods based on application of artificial neural networks for solving of engineering problems along with modelling of optimal structure,  
- use software for simulation of artificial neural networks and analyse and present obtained results

**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. Artificial intelligence - definitions, basic concepts and paradigms. Knowledge bases, knowledge acquisition, models of learning, searching tree, development of soft-computing, autonomous systems. Structure of artificial neural network (ANN), neuron - processing element, transfer (activation) function. ANN models, learning algorithms, uncertainty of system, non-linearity, estimation, clustering. Application of ANN.

**practical teaching**

General principles and simulation examples. Simulation of single-chanel systems, event handling. Introduction to softwares for modelling and analysis of real systems based on discrete event simulation (lab work). Artificial neural networks in intelligent systems. Introduction to softwares for simulation of artificial neural networks (lab work). Recognition

**prerequisite**

Defined by curriculum of study programme/module.

**learning resources**

(1) B. Babic, COMPUTER INTEGRATED SYSTEMS AND TECHNOLOGIES, Faculty of Mechanical Engineering, 2017, 18.1
(2) Z. Miljković, SYSTEMS OF ARTIFICIAL NEURAL NETWORKS IN PRODUCTION TECHNOLOGIES, Series IMS, Vol. 8, University of Belgrade, Faculty of Mechanical Engineering, 2003, 18.1 /In Serbian/
(3) Z. Miljković, D. Aleksendrić, ARTIFICIAL NEURAL NETWORKS – solved examples with short theory background, Textbook, University of Belgrade, Faculty of Mechanical Engineering, 2009, 18.1 /In Serbian/
(4) B. Babic, Z. Miljković, Handouts, University of Belgrade, Faculty of Mechanical Engineering, 2011, 18.1 /In Serbian/
(5) B. Babic, Z. Miljković, Software "Moodle" for distance learning (http://147.91.26.15/moodle/), University of Belgrade, Faculty of Mechanical Engineering, 2011, 18.13
(6) B. Babic, Z. Miljković, Website for Computer simulation and artificial intelligence(http://cent.mas.bg.ac.rs/nastava/ksivi_mo/KSiVI_2009-2010.html), University of Belgrade, Faculty of Mechanical Engineering, 2011, 18.13
(7) AnyLogic simulation software
(8) Z. Miljković, Software packages for simulation of artificial neural networks - BPnet, ART Simulator; Laboratory CeNT website: http://cent.mas.bg.ac.rs/nastava/ksivi_mo/KSiVI_2009-2010.html, University of Belgrade, Faculty of Mechanical Engineering, 18.13

**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, COMPUTER INTEGRATED SYSTEMS AND TECHNOLOGIES, Faculty of Mechanical Engineering, 2017
Manufacturing Technology

ID: MSc-0065

responsible/holder professor: Tanović M. Ljubodrag
teaching professor/s: Babić R. Bojan, Miljković D. Zoran, Popović D. Mihajlo, Puzović M. Radovan, Tanović M. Ljubodrag

level of studies: B.Sc. (undergraduate) academic studies

ECTS credits: 6

final exam: oral

parent department: production engineering

semester.position: 5.3

goals

Manufacturing technology is a science and engineering practice in mechanical engineering and industrial environment to obtain a finished product. The aim of the course is to develop creative skills, in students of all modules, for product design, design for manufacturing and maintenance of industrial equipment in industrial production.

learning outcomes

On successful completion of the course, students should be able to:
- Identify different machining systems and relative motion between the tool and the work-piece to apply them in defining the process of manufacturing technology.
- Select the appropriate base elements for metalworking by cutting (turning, drilling, milling and planing).
- Determine the principle factors of metalworking by plastic deformation for the processes of compression, extruding and drawing.
- Describe in brief the possibility of manufacturing technology for a specified product.

theoretical teaching


practical teaching

PA-1: Historical overview of the manufacturing process; PA-2; PA-3; AR-1; PA-4; AP-2; AR-3; PZ-1: A task in machining process; PZ-2: A task in forging; PZ-3: A task in drawing; PL-1: Metalworking machine tools for chip removal (milling machine, Pfauter milling machine, Fellows planer, grinding machine for flat surface and round grinding); PL-2: Metalworking machine tools for chip removal (lathe, planer and radial drill); PL-3: Metalworking machine tools for deformation processes + Finite-element method using the example of MEKELBA package and simulation of metal forming processes – OSA; PL-4: Technology design for CNC machine tools and industrial robots application.

prerequisite
Defined by the Study Program Curriculum.

**learning resources**

1. Laboratory machines: lathe, planer, radial drill, milling machine, Pfauter milling machine, grinding machine, machining centers, presses, robots, laboratory for FTS, machining processes and tools, ЛПИ.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 5
laboratory exercises: 12
calculation tasks: 13
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: 4
check and assessment of seminar works: 0
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: 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): 30

**references**
Kalajdžić, M. Manufacturing technology, FME, Belgrade, 2006, КДА /In Serbian/
Tanovic Lj., Petrakov J., Theory and simulation of machining processes, FME, Belgrade, 2007 /In Serbian/
Production technology and metrology

ID: MSc-1165
responsible/holder professor: Puzović M. Radovan
teaching professor/s: Puzović M. Radovan, Stojadinović M. Slavenko
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written
parent department: production engineering
semester.position: 5.4

goals

The aims of the course are to acquaint students with theoretical and applied knowledge and regularities in the manufacturing processes and metrological systems in production engineering, using systemic approach. This knowledge helps production engineers to manage treatment and metrological processes in the quality management system.

learning outcomes

Upon successful completion of the course Production Technology and Metrology, studenty should be able to: - Make a plan of the experiment to define and experimentally determine the parameters of machinability functions used to describe characteristic phenomena (mechanical, thermodynamic and tribological) in the cutting zone and by plastic deformation. - Apply measuring devices and data acquisition systems to measure forces, moments, temperature and tool wear parameters in the cutting process (turning and drilling). - Optimize the machining process by means of the productivity function. - Recognize the characteristics of the metrology system in the industry. - Choose the metrology system in relation to the metrological task and the required accuracy. - Design a metrology plan to measure and inspection on CMM. - Followed metrological characteristics of the system in utilization. - Carry out techno-economic analysis of the application of CMM in the industry.

theoretical teaching

AN-1: Basic concepts in the theory of metalworking by plastic deformation;
AN-2: Mechanics of orthogonal cutting;
AN-3; Thermodynamics of cutting process and application of coolants and lubricants;
AN-4: Tribology of cutting process;
AN-5: Material machinability and techno-economy;
AN-6: Essential characteristics of measuring systems in production metrology;
AN-7: Sensors;
AN-8: Analog and digital measuring systems;
AN-9: Pneumatic measuring systems;
AN-10: Laser measuring systems and photoelectric measurement systems.

Each theoretical teaching hour is followed by one hour of explanations relevant to teaching contents.

practical teaching

PR-1: Introductory considerations of production technologies;
PL-1: Determination of deformation in treatment by compression;
PL-2: Resistance measurement in treatment by boring/cutting force;
PL-3: Resistance measurement in treatment by chipping;
PL-4: Methods of cutting temperature measurement;
PL-5: Determination of machinability parameters;
PR-2: Introduction to production metrology;
PL-6: Practical application of metrological systems for length and angle tolerances;
PL-7: Practical application of metrological systems for shape and position tolerances;
PL-8: Practical application of metrological systems for tolerances of micro and macro geometry of surface;
PL-9: Legal metrology, standards of length and angle;
PL-10: Industrial metrology/work on NUMM.

prerequisite
Defined by the Study Program Curriculum.

learning resources

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: 5
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: 15

calculation tasks: 0

seminar works: 0

project design: 0

final exam: 40

requirements to take the exam (number of points): 36

references

Handouts in e-form. /In Serbian/

Instructions for doing laboratory exercises, e-form. /In Serbian/

Monography from area of production metrology (in preparation)

The site with bibliographical references, books and journals from this area and links to the addresses of leading organizations and important institutions in this field

Technical resources for the course: Laboratory for Production metrology and TQM as well as MTL that have necessary equipment and licensed software for doing exercises in this subject
Fundamentals of Rail Vehicles

**ID:** MSc-1030  
**responsible/holder professor:** Milković D. Dragan  
**teaching professor/s:** Milković D. Dragan  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** railway mechanical engineering  
**semester.position:** 6.3

**goals**

1. Understanding the basic rail vehicles assemblies,  
2. Acquiring the knowledge needed for understanding of functioning of the basic structural assemblies,  
3. Training for the application of acquired knowledge for solving practical engineering problems, especially in the field of maintenance of the railway vehicles.

**learning outcomes**

After completing the course, students should be able to:

1. Explain the functional and structural differences between basic types of rolling stock.  
2. Explain the tasks and functioning of the main assemblies of the rail vehicles.  
3. Identify actions required to resolve typical failures in operation and in the maintenance of the rail vehicles.  
4. Apply appropriate regulations and standards in the design and maintenance of the railway vehicles.  
5. Apply basic computer tools for construction and calculation of the simple assemblies of the rail vehicles.

**theoretical teaching**


**practical teaching**

Summary of the design variants of different types of rail vehicles. Examples of selection and limitations of the basic vehicles parameters. Marking of the rail vehicles. The examples and analysis of the regulation excerpts. Load analysis of the wheelsets. Inspection of the wheelsets. Load analysis of the bogie frame. Load analysis of the carbody. Examples of strength calculations. Design variants of the elastic suspension systems. The fundamental parameters of the elastic suspension system and boundary conditions for their selection and calculation. Types of draw-buff gear. Main characteristics of draw-buff gear and their testing. Review of the brake system on the train and on the single vehicle. Inspection of the basic parameters of the new brakes, after repair and in daily operation.
**prerequisite**

Enrolled the third year and desirably completed: Mechanics 1, 2 and 3, The base of the strength of constructions and Machine elements 1 and 2.

**learning resources**

- G. Simic, Fundamentals of rail vehicles, hand-out
- G. Simic, Instructions for writing student papers, hand-out
- G. Simic, Railway vehicles, Design and calculations, Faculty of Mechanical Engineering, 2013.
- 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: 7
seminar works: 3
project design: 0
consultations: 4
discussion and workshop: 5
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: 30
laboratory exercises: 0
calculation tasks: 15
seminar works: 5
project design: 0
final exam: 50
requirements to take the exam (number of points): 25

**references**

Faculty of Mechanical engineering — course catalog — B.Sc. (undergraduate) academic studies
G. Simic, Railway vehicles, Design and calculations, Faculty of Mechanical Engineering, Belgrade 2013.
Life cycle of Railway Vehicles

**ID:** MSc-0388  
**responsible/holder professor:** Lučanin J. Vojkan  
**teaching professor/s:** Lučanin J. Vojkan, Tanasković D. Jovan  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** railway mechanical engineering  
**semester.position:** 6.4

**goals**

1. Introduction to basic concepts important for understanding the life cycle of railway vehicles  
2. Acquiring knowledge necessary to understand the issues of the life cycle of railway vehicles  
3. Training for the application of acquired knowledge in solving practical problems in the design, use and maintenance of railway vehicles

**learning outcomes**

After successfully finishing of course students would be able to:  
- define phases of life cycle of railway vehicles;  
- briefly describe each phase of life cycle of railway vehicles;  
- compare different approaches of realizations of design project and production of railway vehicles;  
- prepare a detailed timeline of the project realization with exactly defined activities;  
- differ reliability, availability and functional suitability of technical systems;  
- discuss about possible ways of raising system reliability.

**theoretical teaching**

Theoretical classes (Definition of rail vehicles and systems as required, Design and production, Use and maintenance, Concept of system effectiveness, Theoretical basis of reliability, Methods of determining the reliability, Prediction of reliability, Allocation of reliability, Failure analysis, System maintenance, The concept of maintenance, Maintenance technologies, Information systems in maintaining, Phase conception - the mission profile and scenario, feasibility studies, operational and maintenance concepts, factors of effectiveness of work and support, criteria for protection and logistical planning, Preliminary phase of development, Preparation of detailed project, Prediction and analysis of technical support, Review of construction, Testing and evaluation, Feedback and corrective action, Production, installation, testing, control and distribution devices, Implementation and data collection on elements of technical support, Use and maintain in the exploitation conditions, Testing process, Capability rating of technical support, Feedback and corrective action, Standards of the International Union of Railways, National standards IEC-EN, Regulations of the national railways in the area of operation and maintenance, Workshops for the maintenance of railway vehicles, General settings of maintenance technology, Technology in railway vehicles maintenance.

**practical teaching**

Practical learning, auditory exercises, assignments, presentation of practical examples in the field of designing, production, use and maintenance. Discussion and workshops.
prerequisite

Attended and passed the course Mechanics 1.

learning resources

Syllabus, Guidebook for solving the tasks, Handouts, Internet resources, articles

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 20

active teaching (practical)

auditory exercises: 28
laboratory exercises: 0
calculation tasks: 2
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: 25
laboratory exercises: 0
calculation tasks: 20
seminar works: 0
project design: 0
final exam: 45
requirements to take the exam (number of points): 35

references
**Railway Systems**

**ID:** MSc-0960  
**responsible/holder professor:** Tanasković D. Jovan  
**teaching professor/s:** Lučanin J. Vojkan, Tanasković D. Jovan  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** oral  
**parent department:** railway mechanical engineering  
**semester.position:** 3.5

**goals**

1. Introducing students with railway transport system.  
2. Introducing students with concept, characteristics, drive systems of railway vehicles and their interaction with railway infrastructure.  
3. Introducing students with systems of passive safety of rail vehicles.

**learning outcomes**

After successfully finishing of course students would be able to:  
- define role, advantages and disadvantages of railway transport;  
- differ types and basic characteristics of railway vehicles;  
- briefly describe characteristics of railway vehicles and their interaction with the railways infrastructure;  
- define and compare role of active and passive safety of railway vehicles;  
- recognize basic infrastructure elements and define their role and main characteristics;  
- describe and differ phases of life cycle of railway vehicles.

**theoretical teaching**

Subsystems of vehicle:  
1. Achieving traction force of vehicles, applied of technics and technologies, adhesion and wear;  
2. Energy supply, traction system and brake system;  
3. Bogies;  
4. Passive Safety of Rail Vehicles  
5. Infrastructure, elements and characteristics;  
6. Freight and passenger traffic, interoperability, management and planning;  
7. Elements of reliability, availability, maintenance and safety, life-cycle costs of rail vehicles.

**practical teaching**

Practical teaching is done through exercises with aim to introduce students with practical solutions which are applied in railway.  
Visits to producers of railway vehicles and components are the primary way of introducing students with railway engineering. On this way, students get insight in production technology and specifics which characterizes this production.
Also, visits the national railway operators with aim to provide direct access to the various systems and technologies are a part of practical exercises: planning and monitoring of traffic, energy supply, infrastructure facilities, and maintenance of railway vehicle.

prerequisite

Students enrolled in the second year of study.

learning resources

Scripts, computer and associated equipment. Professional journals and prospects. Availability resources of national railway operators and Rolling Stock Company.

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: 0
consultations: 5
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: 0
colloquium, with assessment: 6
test, with assessment: 0
final exam: 4

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): 30

references
Skill Praxis B - ZEM

ID: MSc-1184

responsible/holder professor: Milković D. Dragan

teaching professor/s: Lučanin J. Vojkan, Milković D. Dragan, Tanasković D. Jovan

level of studies: B.Sc. (undergraduate) academic studies

ECTS credits: 1

final exam: oral

parent department: railway mechanical engineering

semester.position: 4.5

goals

1. Understanding the fundamentals of design of powered and non-powered rail vehicles
2. Acquire practical insight into the fundamental problems of service management of the rolling stock
3. Acquire practical insight into the basics of organization of the maintenance of rail rolling stock
4. Understanding the fundamentals of the production techniques and production processes that are used for rail vehicles

learning outcomes

After the end of the course the student should be able to:
1. Recognize typical vehicles and their main assemblies of the vehicles existing on the practicing site.
2. Explain the main tasks of the plant where he/she was practicing.
3. Identify the main manufacturing or maintenance techniques and processes used at the practicing site.

theoretical teaching

Instructions for the practice that are defined individually for each student depending on the organization where practice will be done.
Basic safety measures while being on the practice.
Instructions for keeping a diary or writing praxis reports.

practical teaching

The practice, as a rule, is carried out as several days staying in rail vehicle manufacturing, operating or maintaining plants organised by Railway Mechanical Engineering Department. Alternatively, the practice can be done through several one-day visits to various plants related to the rail industry.
During the practice students familiarise with activities, management, techniques and technologies used at the practice site. On this basis, each student fills "Practice Diary" which should show the fundamental elements of management, technology or manufacturing processes or the processes and techniques of maintenance of rail vehicles he/she met in practice.
Upon completion of the practice, students pass the "Diary of practice" to the teacher. Oral presentation and discussion will be organised for the group of students.

prerequisite
Student should attend at least one course in the field of railway vehicles.

**learning resources**

Lučanin V., Theory of traction, Faculty of Mechanical Engineering Belgrade 1996.  
G. Simic, Fundamentals of rail vehicles, hand-out  
G. Simic, Instructions for writing student papers, hand-out  
Documents obtained at the practice plant.

**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: 20  
project design: 0  
consultations: 20  
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: 20  
check and assessment of projects: 0  
colloquium, with assessment: 0  
test, with assessment: 0  
final exam: 20

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

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

**references**
Theory of Traction

ID: MSc-1185
responsible/holder professor: Tanasković D. Jovan
teaching professor/s: Lučanin J. Vojkan, Tanasković D. Jovan
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: oral
parent department: railway mechanical engineering
semester.position: 5.4

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:
- differ basic characteristics of tractive vehicles;
- briefly describe the role and way of functioning of the power transmission and their components;
- recognize basic types of couplings and compare their characteristics;
- describe and differ train resistance;
- calculate of the train resistance and tractive effort;
- recognize importance of application of regulations and standards in the field of railway 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)
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

Attended and passed the course Mechanics 1.

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: 30
laboratory exercises: 0
calculation tasks: 20
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.
Strength of materials

ID: MSc-1192
responsible/holder professor: Andelić M. Nina
teaching professor/s: Andelić M. Nina, Balač M. Igor, Buljak V. Vladimir, Milovančević Đ. Milorad, Milošević-Mitić O. Vesna
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 4
final exam: written+oral
parent department: strength of structures
semester.position: 1.3

goals

The aim of this course is to introduce students to the concepts of stress and strain, the relevant material properties and geometric characteristics of the cross sections. The core of this matter relates to the determination of stress and strain of an elementary loading types (axial loading, torsion, bending). The special attention is in the interpretation of the physicality of the problem, too.

learning outcomes

By mastering the curriculum, the students receive the following skills: mastery of methods, procedures and processes of research; in-depth knowledge and understanding the concept of the strength theory; solving practical problems using scientific methods and procedures; linking basic knowledges from various fields with the aim of making it usable in practice and in various computer programs.

theoretical teaching


practical teaching

Practical instruction: tasks relating to the calculation of geometrical characteristics of the cross-sections (moment of inertia); the calculation of stress and strain in primary loading of structural elements: axial loading (the effect of mechanical forces and temperature, normal stress, static notion of uncertainty, the plan shifts), torsion (shear stress, angle of torsion, dimensioning by the allowed stress and allowable angle), pure bending and bending by forces (distribution of normal stresses and shear stresses in the cross section beams, standard sections, deformation of beams with overhangs and joints). Consultation and individual work tasks in these fields.

prerequisite
The condition is defined by the curriculum program of the study.

**learning resources**

1. Strength of Materials: Milorad Milovančević, Nina Anđelić (tutorial);
2. Tables from the strength of materials: D. Ružić, R.Ćukić, M. Dunjić, M. Milovančević, N. Anđelić, V. Milesevic Mitic;
3. Handouts from the site of the Department of Strength of constructions;

**number of hours**

Total number of hours: 45

**active teaching (theoretical)**

Lectures: 18

**active teaching (practical)**

Auditory exercises: 14
Laboratory exercises: 0
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: 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: 60
Laboratory exercises: 0
Calculation tasks: 0
Seminar works: 0
Project design: 0
Final exam: 30
Requirements to take the exam (number of points): 15

**references**
Fundamentals of Strength of Structures

**ID:** MSc-1193  
**responsible/holder professor:** Milovančević Đ. Milorad  
**teaching professor/s:** Anđelić M. Nina, Balać M. Igor, Buljak V. Vladimir, Milovančević Đ. Milorad, Milošević-Mitić O. Vesna  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written+oral  
**parent department:** strength of structures  
**semester.position:** 2.2

**goals**

The aim of this course is to introduce students to some complex loadings. The bending of the statically indeterminate beams, as well as torsion and buckling of an arbitrary cross sections are considering. Course shows the method of determining the equivalent stresses in a complex spatial loading of structures, that students later can use the computer programs based on Finite Element Method-FEM.

**learning outcomes**

Mastering the program contemplated by this course, students acquire next skills: mastering methods, procedures and processes of research in this field; application the knowledge in this practice; thorough knowledge and understanding of the discipline; solving practical problems using scientific and technical methods and procedures; the possibility of the proper use of computer programs based on Finite Element Method-FEM.

**theoretical teaching**


**practical teaching**

The tasks of buckling. Examples of statically indeterminate beams. Determination of displacements for staticaly determinated plane beam-constructions on bending load. Application of deformation energy and Castigliano’s theorem. Application of the force method for the solution of statically indeterminate problems (external static indefinite beams, symmetrical and closed structures). Calculation of torsional characteristics of various cross-sections. Application of the hypothesis: general considerations, the maximal normal stress, the maximal shear stress and the maximal specific deformation energy of the shape changes. Complex loads constructions - circular and prismatic cross-section, thin-walled cross-sections, standard sections. Examples of displacement method. Consultations and individual work tasks. Laboratory exercise.

**prerequisite**
The condition is defined by the curriculum program of the study.

**learning resources**

2. Handouts from the site of the Department

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 20
laboratory exercises: 5
calculation tasks: 2
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: 5
calculation tasks: 5
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 30

**references**

Faculty of Mechanical engineering — course catalog — B.Sc. (undergraduate) academic studies
Aesthetic Design

**ID:** MSc-0988  
**responsible/holder professor:** Jeli V. Zorana  
**teaching professor/s:** Jeli V. Zorana, Popkonstantinović D. Branislav  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** seminar works  
**parent department:** theory of machanisms and machines  
**semester.position:** 3.5

**goals**

Introducing students to the standards and principles of aesthetics in the design process; recognition of subjective and objective factors forming aesthetic judgment; processing aesthetic elements and principles; the study of geometric legality compliance; use of classic and modern means for creating aesthetic properties; getting to know the characteristics of modern graphic language and aesthetic properties of packaging and advertising.

**learning outcomes**

The student has gained the ability to aesthetic evaluation and the formation of aesthetic judgment; through theoretical and practical classes the student is trained to creatively used to abstract elements and principles of aesthetics and practical (classical and modern) means for creating aesthetic qualities of form.

**theoretical teaching**

Definition Aesthetics and name etymology; term factors and the importance of aesthetic judgment and aesthetic criteria; aesthetics as a factor of visual communication; detailed analysis of the aesthetic design elements form; processing and analysis of basic aesthetic principles-Design forms; processing of geometric principles as essential factors of aesthetics and visual communication; term compliance compositions; methods for creating and presenting aesthetic characteristics (classic and contemporary); sketching and drawing; basic patterns of angled projection, orthogonal axonometry, central projection and perspective; principles of computer modeling shapes using appropriate CAD software concept of modern graphic characters; the role of graphic characters in the context of contemporary visual communication; aesthetics characters, symbols and meanings; aesthetic properties of packaging and packaging products; advertising and product presentation.

**practical teaching**

Independent analysis, creation and presentation of examples on the subject of universal attitudes toward aesthetics and the basic principles of induction aesthetic values and aesthetic evaluation; exercises use aesthetic elements and principles; constructive processing classic geometric legality of aesthetics; classes of classic and modern means of creating and presenting aesthetic qualities of the product; exercises in creating characters with an emphasis on aesthetically-visual meaning.

**prerequisite**

learning resources

Notes: The aesthetics of the product; author: Branislav Popkonstantinović; Necessary additional materials (handouts, setting tasks, seminar papers, etc.) are given on the website or reproduced on paper. Electronic materials larger volume of students may be available in immediate contact. Teaching is realized by combining the video display and table.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 5
laboratory exercises: 6
calculation tasks: 5
seminar works: 7
project design: 0
consultations: 3
discussion and workshop: 3
research: 1

knowledge checks

check and assessment of calculation tasks: 0
check and assessment of lab reports: 2
check and assessment of seminar works: 5
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: 0
test/colloquium: 30
laboratory exercises: 5
calculation tasks: 5
seminar works: 30
project design: 0
final exam: 30
requirements to take the exam (number of points): 35

references
Basic technological operations in food industry

ID: MSc-1110
responsible/holder professor: Jeli V. Zorana
teaching professor/s: Veg A. Emil, Jeli V. Zorana, Miladinović D. Ljubomir, Popkonstantinović D. Branislav, Šiniković B. Goran
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: theory of machanisms and machines
semester.position: 6.3

goals

1. Acquiring basic knowledge of the physical, chemical and biological changes in materials processed during the technological process in the food industry. 2. Getting acquainted with the basic concepts necessary for dealing with matter in the field of food technology and food science. 3. Division of basic technological operations that are encountered in the food industry, primarily in the mill-bakery-confectionery, dairy, slaughterhouse and butchery and vegetable-growing industry. 4. Means of food engineering in food technology.

learning outcomes


theoretical teaching


**practical teaching**

First laboratory exercise: going to the plant dealing with mechanical operations in the food processing industry, monitoring of mechanical operations, report. Second laboratory Exercise: Start-up in which thermal operations are performed in the production of food products, monitoring operations and writing reports. Third laboratory exercise: visits to food processing plants, analysis and transcription of the transcript, writing reports. Preparation of a project which includes the definition of the project task, the necessary calculations and the drafting of the complete technological process of the finished food product. Consultations: consideration of completed active teaching and students’ questions.

**prerequisite**


**learning resources**

Script in preparation, Z. Jeli. In order to successfully overcame the subject, it is necessary to use the instructions for creating projects, handouts, Internet resources and videos.

**number of hours**

total number of hours: 75

**active teaching (theoretical)**

lectures: 30

**active teaching (practical)**

auditory exercises: 2
laboratory exercises: 6
calculation tasks: 4
seminar works: 0
project design: 15
consultations: 3
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: 2
test, with assessment: 0
final exam: 5

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

feedback during course study: 5
test/colloquium: 25
laboratory exercises: 15
calculation tasks: 0
seminar works: 0
project design: 25
final exam: 30
requirements to take the exam (number of points): 42

references
CONSTRUCTIVE GEOMETRY AND GRAPHICS

**ID:** MSc-0203  
**responsible/holder professor:** Popkonstantinović D. Branislav  
**teaching professor/s:** Veg A. Emil, Jeli V. Zorana, Miladinović D. Ljubomir, Popkonstantinović D. Branislav, Šiniković B. Goran  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 2  
**final exam:** written  
**parent department:** theory of mechanisms and machines  
**semester.position:** 1.3

**goals**

The objectives of this course are to acquire knowledge for comprehending, constructive processing and modeling of the objects of three-dimensional space. Practicing and mastering the basic operations and methods for efficient geometric analysis and synthesis of various abstract and concrete forms can be considered as the study program objective. Moreover, particularly important goal of this course is the theoretical preparation and development of creative skills for effective use of modern software packages for three-dimensional modeling and design.

**learning outcomes**

Mastering the program, students obtain and improve ability to use geometric operations and methods for creative observation and modeling of three-dimensional space. In addition, the adoption of the scheduled curriculum, a student acquires the knowledge and skills for effective visual communication in engineering practice.

**theoretical teaching**

Theoretical course includes:
1) Learning the principles of the Constructive geometry and graphics (CGG), introducing the concepts of projection, orthogonal projections, coordinate systems and spatial coordinates, defining elements, relations, and CGG postulates; explanation of the basic CGG methods;  
2) Application of the CGG methods; treatment of classical positional and metric problems;  
3) The constructive geometrical analysis and treating of a plane in arbitrary position; the plane revolution, the oblique plane figures;  
4) The constructive geometrical analysis and treating of an objects on an incline plane, the spatial positional and metric problems;  
5) The polyhedron truncation (truncation of pyramids and prisms), learning the basic principles and constructive geometrical methods of developing surfaces (the net); building the concrete models of truncated prisms and pyramids;

**practical teaching**

Practical lectures are conducted through a cycle of exercise consisting of 6 auditory and 6 independent individual exercises. Auditory exercises students accomplish in college with the help of assistants, and independent practice through homework. The exercises are performed with the following contents:
1. The orthogonal projections delineation, training the use of spatial coordinates, three-dimensional coordinate system and the main issues and postulates of CGG;  
2. Practising the basic methods of CGG (transformation and revolution)
3. Application of CGG methods (the measure of lengths, angles, area); practicing the classical positional and metric problems;
4. The constructive geometrical analysis and treating of a plane in arbitrary position, practicing the procedures of geometric plane revolution and modeling of geometrical figures on an oblique plane;
5. Spatial positional and metric problems; constructive analysis and synthesis of geometrical objects on an incline plane;
6. Truncation of pyramids and prisms; practicing the methods and procedures of surface developing (the net) and modeling of a truncated pyramids and prisms;

**prerequisite**

The course of Constructive geometry and graphics is mandatory for all students.

**learning resources**

1. Tutorial: CONSTRUCTIVE GEOMETRY AND GRAPHICS; authors: Dr. Aleksandar Veg, Miodrag Stoimenov, Ljubomir Miladinovic, Branislav Popkonstantinović; Faculty of Mechanical Engineering, Belgrade 2005.
2. Handbook for practice: A constructive geometry in the graphics - PRACTICUM; authors: Dr. Branislav Popkonstantinović, Mr. Zoran ate, Mr. Rasa Andrejevic, Goran Šiniković; Faculty of Mechanical Engineering, Belgrade 2010.

Note: The textbook and handbook are available in printed form.

**number of hours**

total number of hours: 30

**active teaching (theoretical)**

lectures: 11

**active teaching (practical)**

auditory exercises: 5
laboratory exercises: 0
calculation tasks: 6
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: 1
test, with assessment: 0
final exam: 2
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
Engineering Graphics

**ID:** MSc-1173  
**responsible/holder professor:** Miladinović D. Ljubomir  
**teaching professor/s:** Veg A. Emil, Jeli V. Zorana, Miladinović D. Ljubomir, Popkonstantinović D. Branislav, Šiniković B. Goran  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** theory of mechanisms and machines  
**semester.position:** 2.3

**goals**

The goal of the course is that students master the skills necessary for successful viewing (and reading) of machine parts components technical drawings. The student should know all the rules and standards that are used for formatting, dimensioning and defining of the machine parts machining on the drawings.

**learning outcomes**

The outcome of this course is the students’ ability to model mechanical parts as well as their assemblies by the using of the software package SolidWorks. Moreover, it is necessary to show the assemblies and parts on drawings with the appropriate sections so that they can be fully formally, dimension and machining defined.

**theoretical teaching**

Drawing in Mechanical Engineering; displaying objects in the drawing; composition parts, pictures of objects. Axonometric projection of objects and their interpretation. Views; basic views; separate views; types of lines in mechanical engineering. Sections, a complete cross-section; half cross-section, partial cross-section, labeling section; profile sections. Breakthroughs; symmetrical parts, repeated details. Dimensioning; function wheel; elements of Dimensioning; marking point on the drawing; methods quotation. Threads display; coil; threaded double and tags for loops. Marking sheet surface; surface roughness; means for quality of workmanship, labeling on the drawings. Technical Letter; scale, the formats, headers and components; positional label elements. Gear display; Springs display; Welded seams display. Shape and position tolerances.

**practical teaching**

Introduction to SolidWorks software package; Making 3D model of simple machine part, display the same model in three main respects. Production 3D model of machine parts and its clarity of the presentation by the three main views. Production 3D model of machine part and its representation by imaginary sections in three major respects. Preparation 3D model of a given machine part; making technical drawings in sufficient numbers of views using the imaginary section; the using of special views and sections; dimensioning part of the drawing. Molding all parts of the assembly Press device(Clamp device); switching production drawings in sufficient number of views with appropriate labeling and providing a measure of dimensions, making components, filling tables in the drawing, drafting workshop drawings for at least three part of the circuit which are connected together; numbering workshop drawings in accordance with the numbering of the assembly. Creating 3D model for three possible models for the (complex) mechanical parts, development of appropriate technical
drawings in a sufficient number of views, using reflective section; application of particular views and cross sections; dimensioning; indication the quality of roughness.

prerequisite

No condition.

learning resources


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: 5
test/colloquium: 40
laboratory exercises: 25
calculation tasks: 0
seminar works: 0
project design: 0
final exam: 30
requirements to take the exam (number of points): 20

references
Hidraulic and Pneumatic Mechanisms and Piping

**ID:** MSc-0252  
**responsible/holder professor:** Miladinović D. Ljubomir  
**teaching professor/s:** Veg A. Emil, Miladinović D. Ljubomir  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** project design  
**parent department:** theory of mechanisms and machines  
**semester.position:** 6.4

**goals**

Acquisition of all necessary knowledge for the development and calculation of pneumatic and hydraulic installations. Presentation of all symbols for both fields. The use of hydraulic and pneumatic components as a drive for modern machines in different branches. Using pneumatics as factory energy. Regulations and standards for the development of the central pneumatic distribution.

**learning outcomes**

At the end of this course the student should be able to interpret the pneumatic and hydraulic schemes. To be able to design mechanisms and electro pneumatic systems for synchronization of machines. It also should be able to design hydraulic mechanisms, i.e. driving systems for machines and devices.

**theoretical teaching**


**practical teaching**


**prerequisite**

To attend classes of the subject Hidraulic and Pneumatic Mechanisms and Piping, no condition is necessary.
learning resources


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: 9
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: 4
check and assessment of seminar works: 4
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: 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
Mechanisms Design

ID: MSc-1109

responsible/holder professor: Popkonstantinović D. Branislav
teaching professor/s: Miladinović D. Ljubomir, Popkonstantinović D. Branislav

level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written

parent department: theory of mechanisms and machines

semester.position: 5.5

goals

acquiring the necessary knowledge and developing creative abilities for designing and constructing mechanisms within machines and devices. Mastering some of the software programs for concrete construction of mechanisms (machines and devices), or analyzing their work in order to eliminate the observed shortcomings.

learning outcomes

By mastering the study program, student acquires the following subject-specific abilities: understanding the problems from the theory of mechanisms and machines; solving concrete problems using scientific methods and using adequate software.

theoretical teaching

Introduction to the theory of mechanisms, mechanism structure, kinematic member, kinematic pair, kinematic chain, number of degrees of freedom of movement; The basic mechanism, the synthesis of a complex mechanism, the Assur group; Conditions of Grashof, flat and spatial mechanisms; Kinematics mechanisms, instant centers of rotation, kinematic pair speeds, angular speeds of kinematic members. Acceleration of kinematical pairs, angular acceleration of kinematic members; Dynamics of mechanisms, external and inertial forces and moments in the mechanism; The driving force (moment), the Zhukovsky theorem, the forces (pressures) in kinematic pairs; About synthesis of mechanisms, optimal synthesis of mechanisms in MATLAB; Optimal parametric synthesis of mechanisms, target function; Limits and penalties within the objective function; Real mechanisms, friction and angles of friction in kinematic pairs.

practical teaching

Structure of mechanisms, kinematic member, kinematic pair, kinematic chain; Obtaining the skills on Solidworks, modeling a member, modeling a kinematics pair; Modeling the kinematic chain, selecting and adjusting the drive; Adjusting the accuracy of the mechanism, reading the position of the kinematic pair or member; Reading current speeds of kinematic pairs and angular speed members, forming a speed diagram in the cycle of the mechanism; Reading the acceleration of the kinematic pair and the angular acceleration of the member, forming an acceleration diagram; Inserting external forces and moments into the mechanism, adjusting the drive mode; Introduction and adjustment of coefficient and radius of friction in kinematic pair, reading of force in kinematic pairs, formation of force diagram in cycle; MATLAB, writing one part of the synthesis program in MATLAB; Parametric optimal synthesis of the mechanism for a given path (MATLAB); Construction by the synthesis of the obtained mechanism in Solidworks.
prerequisite

Not specified.

learning resources

Available only on Serbian.

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 0
laboratory exercises: 10
calculation tasks: 20
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: 15
test, with assessment: 0
final exam: 0

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): 50

references
Skill Praxis B - PRM

ID: MSc-1174
responsible/holder professor: Jeli V. Zorana
teaching professor/s: Jeli V. Zorana
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 1
final exam: written
parent department: theory of machanisms and machines
semester.position: 4.5

goals

1. Getting acquainted with the machine materials needed for use in the manufacture of foodstuffs. 2. Practical application of knowledge from engineering graphics and solid modeling. 3. Developing students’ creative abilities for designing food devices, machines and systems by analyzing the construction and exploitation characteristics of food machinery and plants.

learning outcomes

By mastering the study program the student acquires the ability: 1. Analysis of existing solutions and their effects 2. Adoption of practical knowledge 3. Application of knowledge in practice 4. Knowledge and understanding of the problems of technological procedures in food production

theoretical teaching

Introduction to the subject. Food industry as an important branch of the country's economy. Classification within the food industry to groups and subgroups. Basic characteristics of certain groups and subgroups. Basic technological procedures in the production of food products. Industrial production of flour, sugar, edible oils, fats, etc. Processing of fruits and vegetables. Industrial production of milk and dairy products. Production of meat and meat products. Manufacture of bakery, confectionery and confectionery products. Manufacture of pasta. Manufacture of alcoholic and non-alcoholic beverages.

practical teaching

Familiarizing with the production process in working organizations engaged in the production of food products covered by lectures. Tour companies that design and construct plants, as well as production of food processing equipment. Tours of companies engaged in the production of food products. Familiarizing with the production process and affirmative introduction to the basic equipment in the food industry. Introduction to basic technological operations in the food industry. Preparation of the seminar project according to the experience acquired in the companies. Review and evaluation of seminar paper (journal of practice) that includes the material that is returned.

prerequisite

There are no additional conditions for attending Skill Practice(B.Sc.)-Food Engineering

learning resources
In order to successfully master the subject, it is necessary to use Internet resources, prospect materials, which are available by manufacturers and users of food equipment and videos. Instructions for writing a journal of practice and seminar papers.

**number of hours**

total number of hours: 90

**active teaching (theoretical)**

lectures: 40

**active teaching (practical)**

auditory exercises: 15
laboratory exercises: 0
calculation tasks: 0
seminar works: 25
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: 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): 0

**references**
Introduction to Energetics

ID: MSc-0406
responsible/holder professor: Stevanović D. Vladimir
teaching professor/s: Bajc S. Tamara, Ilić B. Dejan, Milivojević S. Sanja, Petrović V. Milan, Stevanović D. Vladimir, Todorović N. Maja
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written
parent department: thermal power engineering
semester.position: 4.4

goals

The aim is to obtain academic knowledge about the processes and equipment for exploitation of fossil fuels’ primary energy, hydropower, nuclear power, geothermal, solar and wind energy, conversion and transformation of primary into secondary energy forms, such as heat, mechanical work, electricity, transport as well as distribution of energy and working fluid, energy storage, and utilization of energy in final consumption for heating, air conditioning and refrigeration.

learning outcomes

Students acquire basic knowledge of technological systems, energy equipment and processes in thermal power plants, hydro power plants, boiler plants, nuclear power plants and heating systems, refrigeration and air conditioning systems. Students become familiar with the processes and technical solutions of turbomachinery, such as water turbines, steam and gas turbines, pumps, fans and compressors, as well as advanced methods and solutions for efficient energy consumption, environmental protection and analysis of macroenergy system.

theoretical teaching

Macroenergy systems and energy flows. Energy, economic and technological indicators of the energy system. Energy of fluid flow, the basic operating principles of turbomachinery, a classification according to the direction of energy transfer, the type of fluid. Pumps and pumping stations. Hydroenergy plants and hydraulic machines. The basic operating principles of steam turbines and their application. The basic operating principles of gas turbines and their application. Thermal power plants and the outline of the main and auxiliary technological systems. Heat and electricity co-generation. Environmental protection in thermoenergetics. Boiler plants, boilers and appliances. Application of boilers. Appliances and furnaces for burning solid (coal, biomass, urban waste), liquid and gaseous fuels. Machines for cooling/refrigeration, natural and artificial cooling. The processes and equipment for obtaining low temperatures. Systems for heating, ventilation, air conditioning and hot water. The energy efficiency in heating and air conditioning. New and renewable energy sources.

practical teaching

Energy consumption in the World and in Serbia. Examples of development of pumps, fans and water turbines. Demonstration of pumps with corresponding fittings in laboratory installation. Hydroelectric power plants. Heat and technological schemes, the basic systems and components of steam power plants. Gas turbines application in energetics and transport. Examples of combined cycle power plants. The calculation of fuel consumption and thermal
power plants’ efficiency. Emissions of exhaust gasses and environmental protection in thermoenergetics. A visit to a thermal power plant or a laboratory. Chronological development of steam boilers. Classification of heat boilers according to heat carrier (hot water, pressurized water and steam). Basic components of the boiler. Applications of refrigerant equipment and heat pumps. Energy consumption for heating of flats in Belgrade. Calculation of annual energy consumption for heating of various types of housing and different levels of thermal insulation. Examples of energy efficiency in the field of air conditioning, heating and refrigerant systems in the World and in Serbia.

**prerequisite**

It is advisable to have passed the following exams: Mathematics 1 and Physics and measurements.

**learning resources**

Course 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: 5
test, with assessment: 5
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): 30

references

Skill Praxix B - TEN

ID: MSc-1205
responsible/holder professor: Petrović V. Milan
teaching professor/s: Petrović V. Milan, Stevanović D. Vladimir
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 1
final exam: oral
parent department: thermal power engineering
semester.position: 4.5

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.
Heating technique fundamentals

ID: MSc-1178
responsible/holder professor: Bajc S. Tamara
teaching professor/s: Bajc S. Tamara, Todorović N. Maja
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written+oral
parent department: thermal science engineering
semester.position: 6.4

goals

Acquiring knowledge and skills in the field of heating technology - the impact of climate parameters and conditions of comfort, heating bodies, additional elements and equipment, types and mechanisms of heat transfer; acquiring knowledge of methods for calculation of heat losses according to different standards and use these methods when developing main mechanical project of central heating systems.

learning outcomes

Students acquire specific skills and knowledge in heating technology: they are familiar with elements of central heating systems; familiar with heat losses calculation methods and can apply them in practice. Student can connect basic knowledge and apply it to solve concrete problems in the technique of heating.

theoretical teaching

Thermal parameters of the environment; comfort conditions, characteristics of the external climate and the impact on thermal comfort conditions; calculation method for external project temperature heating; heat transfer through the building envelope construction, heat bridges, condensation, natural ventilation, wind effect on air infiltration, calculation of needed amount of heat for heating using different standards, heating equipment division, radiators and valves, types of heat transfer, heat radiators disclosure depending on the temperature of fluid; testing heaters; heating sources in central heating systems, insurance and boiler fittings, boiler room and its elements, open and closed expansion vessel; annual energy consumption calculation, the calculation of fuel consumption, different systems of central heating.

practical teaching

Auditory exercises consisting of several parts: heat transfer through the building envelope construction, determining the thickness of insulation, ventilation calculation of transmission and heat loss and sizing of heaters, boilers and related equipment, with the aim of making solo project task. Laboratory exercise is a demonstration - elements of the installation heating, valves, pipe insulation, thermal properties testing radiator. It is envisaged to visit the fair and techniques or factory that manufactures heating equipment.

prerequisite

Student must have passed the exam in Thermodynamics B in order to follow the course.

learning resources
Handouts - M. Todorović
Central heating systems design - B. Todorović

**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.
M. Todorović: Fundamentals of heating technique, handouts
Skill praxis B - TTA

ID: MSc-1203
responsible/holder professor: Todorović N. Maja
teaching professor/s: Todorović N. Maja
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 1
final exam: written
parent department: thermal science engineering
semester.position: 4.5

goals

The aim of this course is to introduce students to the process of design and construction of HVAC systems, processes and HVAC systems, elements of the production process and HVAC systems equipment, methods of calculation used in the design of HVAC systems, introduction to the technological production lines in factories, quality control, work organization and systems maintenance.

learning outcomes

By the successful completion of the course students are introduced to: the elements of HVAC installations, methods of process analysis and installations design, system operating parameters measurement etc.

theoretical teaching

Introduction. The role and importance of professional practice in educationof thermal science engineers. Basic principles of systems for heating, cooling, ventilation, air conditioning and heat generation plants. Basic processes in HVAC plants. Measurement & Instrumentation systems applied in thermal science. Instructions for daybook keeping.

practical teaching

Organization of visits to factories and firms• design and consulting organizations in the field of thermal engineering • organizations that manufacture machines and equipment in the field of thermal engineering • organizations involved in the maintenance, measurement and HVAC installations regulation• organizations involved in the execution of HVAC installations • companies involved in heat production and district heating plants • thermal power plants and combined heat and power production. In an independent work, students are completing the technical report of practice. The report is submitted in the form of the daybook. The final exam includes an oral defense of the daybook after practice is completed.

prerequisite

no conditions

learning resources

Handouts and documents provided by the responsible person from the company

number of hours
total number of hours: 90

**active teaching (theoretical)**

lectures: 2

**active teaching (practical)**

auditory exercises: 0
laboratory exercises: 78
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**

M. Todorović: Fundamentals of heating technique, Handouts
Thermodynamics B

ID: MSc-0372
responsible(holder) professor: Gojak D. Milan
teaching professor(s): Banjac J. Miloš, Gojak D. Milan, Komatina S. Mirko, Rudonja R. Nedžad
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: oral
parent department: thermomechanics
semester.position: 4.1

goals

Understanding and acquiring the fundamental thermodynamic principles and laws, and knowledge of thermodynamic states and state changes of matters included in energy transformations processes. Understanding the principles of operation of thermal engines and refrigeration devices, and knowledge of fundamentals of the energy transfer by heat.

learning outcomes

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

• Implement the law of conservation of energy for different processes in thermodynamic systems;
• Determine the properties of different substances (ideal gases and their mixtures, water–steam and other pure substances) as well as the performed work and amount of the transferred heat in different thermodynamic changes of state of substances;
• Implement the Second law of thermodynamics for processes in thermodynamic systems;
• Explain the thermodynamic principle of operation of heat engines and analyze basic heat engines cycles (Carnot, in IC engines, the gas-turbine and steam-turbine plants and others);
• Explain the thermodynamic principle of operation of refrigeration equipment and heat pumps and analyze the basic refrigeration cycles (Carnot, air and vapor compression cycles);
• Calculate and analyze the basic modes of heat transfer (conduction, convection, radiation, combined heat transfer phenomena).

theoretical teaching


practical teaching

prerequisite

As defined by the program of studies curriculum.

learning resources

1. Handouts
2. Kozić, Đ., Vasiljević, B., Bekavac, V.: Handbook for thermodynamics, Faculty of Mechanical Engineering, Belgrade

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 24
laboratory exercises: 0
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: 6
test, with assessment: 2
final exam: 2

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

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

references

Milinčić, D., Voronjec, D.: Thermodynamics, Faculty of Mechanical Engineering, Belgrade (in Serbian)
Kozić, Đ.: Thermodynamics - engineering aspects, Faculty of Mechanical Engineering, Belgrade (in Serbian)
Vasiljević, B., Banjac, M.: Map for thermodynamics, Faculty of Mechanical Engineering, Belgrade (in Serbian)
Voronjec, D., Đorđević, R., Vasiljević, B., Kozić, Đ., Bekavac, V.: Solved problems in thermodynamics with extracts from theory, Faculty of Mechanical Engineering, Belgrade (in Serbian)
Đorđević, B., Valent, V., Šerbanović, S.: Thermodynamics with thermal engineering, Faculty of Technology and Metallurgy, Belgrade (in Serbian)
Classical Armament Design

**ID:** MSc-0057  
**responsible/holder professor:** Micković M. Dejan  
**teaching professor/s:** Micković M. Dejan  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** weapon systems  
**semester.position:** 6.3

**goals**

Introducing students to the basics of construction of artillery weapons, small arms, automatic cannons, armoured vehicles and tanks. The study of basic tactical - technical requirements, processes that occur during firing, and the principles of operation, determining the structural solutions of certain systems. Analysis of individual structural elements of different classical armament systems.

**learning outcomes**

Mastering the basic principles of the design of classical armament systems. Qualification for the calculation of basic parameters of processes that determine the design of individual systems. The basis for the later detailed study of artillery and automatic weapons design.

**theoretical teaching**


**practical teaching**


**prerequisite**

There are no special conditions for attending the subject.
learning resources

1. Micković D.: Classical armament design - Handouts
2. Vasiljević M.: Automatic weapons, TŠC KoV JNA, Zagreb

number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 28
laboratory exercises: 0
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: 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): 30

references

Handbook on Weaponry, Rheinmetal GmbH, Dusseldorf, 1982
Flight Mechanics of the projectile

**ID:** MSc-1083  
**responsible/holder professor:** Todić N. Ivana  
**teaching professor/s:** Todić N. Ivana  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** weapon systems  
**semester.position:** 5.5

**goals**

Introducing students to the basics of flight mechanics, including aerodynamics, and its tasks. Setting up the basic equations of mechanics of flight and principles for solving them. Basic knowledge of the forces and torques acting on the missile during flight. Behavior on the trajectory: the stability of of the projectile, missile control methods. Application of the flight mechanics: preliminary weapon design, firing tables, fire control systems.

**learning outcomes**

Knowledge of principles and basic equations of mechanics of flight of the projectile. Ability to work on aerodynamic calculations and modeling the mechanics of flight of the projectile. Basic knowledge of stability and control methods.

**theoretical teaching**

Introduction to the mechanics of flight of the projectile; basic terms. The main tasks of the flight mechanics (primary and reversible). Trajectory elements and type of trajectories. External conditions (Earth's atmosphere and gravitational field) and the initial conditions. Coordinate frames and transformations. The basic equations of flight mechanic (Newton and Euler equations). The forces and torques acting on the projectile (gravitational, aerodynamic, propulsion and control). Aerodynamics as a special area of mechanics of flight; basic principles of missile aerodynamic. The aerodynamic coefficients and gradients. Methods aerodynamic control. Aerodynamic design. The basic calculation method of flight mechanic (approximate & numerical). Missiles behavior - stability and maneuverability (basic). Guided missiles and control methods (basic). Preliminary design of the missile. Firing tables. Fire Control Systems.

**practical teaching**


**prerequisite**

None.  
It is desirable that the student has passed the mandatory mechanics.
learning resources


number of hours

total number of hours: 75

active teaching (theoretical)

lectures: 30

active teaching (practical)

auditory exercises: 5
laboratory exercises: 0
calculation tasks: 10
seminar works: 5
project design: 0
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: 10
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): 25

references

Janković, S.: Aerodinamika projektila, Mašinski fakultet Univerziteta u Beogradu, 1979
Fundamentals of Projectiles Propulsion

ID: MSc-1135
responsible/holder professor: Micković M. Dejan
teaching professor/s: Elek M. Predrag, Micković M. Dejan
level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 6
final exam: written
parent department: weapon systems
semester.position: 5.4

goals

Introducing students to the basics of projectile propulsion, including classic and rocket propulsion. Study of fundamental processes that occur during firing in the gun barrel and in the rocket motor chamber. Influence of characteristics of propellants on firing processes. Setting up a system of equations describing these processes and methods for solving the system. Application of propulsion software packages. Design of propellant systems.

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 and rocket propulsion. Student acquires fundamentals for subsequent detailed study of various types of propulsion.

theoretical teaching

1. Introduction to propellant systems.
2. Classification of propulsion systems (classical and rocket).
4. Basic processes and laws during the firing process. The main tasks of the internal ballistics.
6. Basics of reactive propulsion; classification of reactive propulsion (air-breathing and rocket); classification of rocket propulsion (liquid, solid and hybrid).
7. The basic equations of propulsion systems performances.
10. Fundamentals of rocket motors with solid propellants.

practical teaching

1. Combustion of gunpowder. Examples of calculations
4. The basic equations of propulsion systems performances. Problems
5. Fundamentals of rocket engines with liquid propellants. Selected examples
6. Fundamentals of rocket propulsion with solid propellants. Selected examples
7. Software packages for reactive motor performance calculation. Examples and demonstrations.
prerequisite

No obligatory prerequisites. Passes exam preferred: Fundamentals of weapon 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: 6
calculation tasks: 12
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
Fundamentals of Weapon System Design

ID: MSc-0408

responsible/holder professor: Micković M. Dejan

teaching professor/s: Micković M. Dejan

level of studies: B.Sc. (undergraduate) academic studies

ECTS credits: 6

final exam: written

parent department: weapon systems

semester.position: 4.4

goals

Students should have the basic knowledge of the general methods of weapons systems design. The goal is to provide students with an integrated overview of the most important fields of defense technology and appropriate methods of design and construction. The subject should serve as a basis for a thorough study of individual areas of weapons systems.

learning outcomes

Students should obtain the basic knowledge of the general methods of weapons systems design. The goal is to provide students with an integrated overview of the most important fields of defense technology and appropriate methods of design and construction. The subject should serve as a basis for a thorough study of individual areas in the field of weapons systems.

theoretical teaching

1. Introduction to methods of weapons systems design,
2. Internal ballistics (Main features of the firing process,...),
3. Rocket propulsion (Basis of reactive propulsion and division,...),
4. Aerodynamics of the projectile (Fundamentals of aerodynamics, ...),
5. Projectile flight dynamics (main tasks of the projectile flight dynamics,...),
6. Construction of projectiles (projectile safety during movement through the gun tube, ...),
7. Construction of artillery weapons (barrel, muzzle brake, breechblock,...),
8. Construction of automatic weapons,
9. Construction of missiles (Basic equations spending rocket fuel and missile movements, ...),
10. Construction of rocket launchers (rocket launch types and main characteristics, ...),
11. Optical instruments and sighting devices (theory of light and geometric optics,...).

practical teaching

1. Internal ballistics - examples
2. Rocket propulsion - examples
3. Projectile Aerodynamics - examples of calculations
4. Projectile flight dynamics - examples of calculations
5. Construction of projectiles - solving problems
6. Construction of artillery weapons - examples, analysis and comparison
7. Construction of automatic weapons - examples, analysis and comparison
8. Construction of missiles - examples of calculations
9. Construction of rocket launchers - examples of calculations
10. Optical instruments and sighting devices - examples and calculations
prerequisite

There are no special conditions for attending the subject.

learning resources

1. Jaramaz S., Blagojevic Đ., Milinovic M., Micković D.: Handouts

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: 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
**Introduction to Weapon Systems**

**ID:** MSc-1134  
**responsible/holder professor:** Milinović P. Momčilo  
**teaching professor/s:** Milinović P. Momčilo  
**level of studies:** B.Sc. (undergraduate) academic studies  
**ECTS credits:** 6  
**final exam:** written  
**parent department:** weapon systems  
**semester.position:** 3.5

**goals**  
The main objective of this course is to introduce students to the field of weapons systems. Students get basic knowledge in the field of defense technologies, and learn the classification, purpose, importance and basic principles underlying the modern weapon systems. Gain insight into the complexity and variety of weapons systems and get a clear overview of this multidisciplinary field.

**learning outcomes**  
Student gets the necessary basic knowledge of weapons systems that include classification, purpose and key principles of their action. Student has a complete overview of the field of classical and rocket weapon systems.

**theoretical teaching**  
1. Development of conventional weapons systems,  
2. Classic weapons (small arms, artillery weapons, anti-armor systems, air-defense systems),  
3. Ammunition (division of projectiles, explosives, small arms ammunition, high-explosive missiles, KE projectiles, shaped charge projectiles, cargo ammunition, fuzes),  
4. Platform of weapon systems (tanks, classification of other armored vehicles),  
5. Rocket systems (the basic principle of rocket motion, classification and characteristics of military rocket and missile systems, the main characteristics of anti-armor missile, air-defense missiles, the main characteristics of artillery rocket systems MLRS)  
6. Data acquisition systems,  
7. Fire control systems,  
8. Guidance and control of missiles.

**practical teaching**  
1. Classic weapons - analysis and comparison of solutions implemented in practice,  
3. Ammunition - types of projectiles, the main characteristics, the analysis of realized designs  
4. Platform of weapon systems - the analysis of implemented solutions, comparison,  
5. rocket systems - fundamentals of rocket motion, types of missiles, the analysis of realized designs  
6. Data acquisition systems - examples of sensors and their analysis  
7. Fire control systems - an analysis of different types of FCS  
8. Guidance and control of missiles - Analysis and comparison of different types of guidance and control systems.

**prerequisite**
learning resources

1. Handouts for lessons

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: 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
Missile weapon design

ID: MSc-0254

responsible/holder professor: Milinović P. Momčilo

teaching professor/s: Milinović P. Momčilo

level of studies: B.Sc. (undergraduate) academic studies

ECTS credits: 6

final exam: written

parent department: weapon systems

semester.position: 6.4

goals

Goal of subject is to achieve competitive academic knowledge and skills in the analyzes and syntheses of the main missiles and rocket system performances. Also, goal is to realize knowledge about special missile and rocket performances, as the special flight vehicle and ballistic object, with their distinguishing features, applicable for weapon or ammunition syntheses comparing with other types of weapon and projectiles. Student or applicant developing creative capabilities, in the directed mechanical engineering, skills for the basic professional orientation of weapon design engineering. Theoretical applications and practical examples of missile, rockets diversification and integration design cases is the knowledge goal of student creative course work, as the bachelor basic knowledge of weapon designers.

learning outcomes

Student achieve possibilities of analyzes and syntheses for the expert solutions of weapon missile and rocket systems, project, design, feasibility and other study approaches integrations. Output includes methodology and proceedings of specific research knowledge of mathematics, mechanics, propulsion, propellants and its software applications in missiles systems design. Student developing critical approach of weapon missiles system and design and possibility to employ knowledge in practical work also, in information exchanging about relevant references. Also, understand principal performances of missiles and rocket weapon systems and differences its design differences and applied different technologies and branches of research in this area.

theoretical teaching

1. Subtopics

Defense efficiency and role of missiles and rockets in military technology.

1. Types and diversification of missiles and rocket projectiles, and its basic subsystems components and main parts. Components and subsystems principal functions, and performances integration and analyses. Functional design of missiles and rockets and differences in flight and componental content.

2. subtopics

Mass model and Tziolkowsky velocities of missiles and rockets, payload analyses for rocket, and special for missiles and its differences. Basic propulsion and rocket engines integration performances. Dimensions, gravity centers, and inertial properties of missiles and rockets. Design concept of aerodynamically and components and frames, energetic concept, and flight range, height, precision and ballistic requirements, for missiles and special for rockets.

3. Subtopics

Forces, aerodynamically, gravity, propulsion and control guidance, their moments, as the
loads, on the start during launching, in the flight and in the terminal phase. Basic principles of internal and external strain and stress analyzes of missiles body and components.

4. Subtopics
Multilaunching missiles and rocket systems, separation phases, payloads on the launching and in the flight, separation of start systems and mass models analyzes.

5. Subtopics
Launching mechanics stability, basic launching system components, and functions and weapon systems diversifications in launcher, missiles, and rockets flight integration.

**practical teaching**

1. Design of technical and functional requirements of the missile and rocket systems
Precision and accuracy of missiles and rockets and employment capabilities.
Integration of missiles and rockets with different subsystems in the missile body.

Practical calculation performances
4. Stability of launching and mass model development of the weapon system, and missile.
Calculation examples.

5. Concept of development of seminar paper for probability study of rocket or missile systems from the references of weapon. Presentation and text paper.
6. Experimental testing of missile properties, frame plan of performances evaluation

**prerequisite**

none

**learning resources**

1. M. Milinovic: Basics of missiles and launchers design (serb), University of Belgrade Faculty of ME 2002., textbook
3. 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: 16
laboratory exercises: 5
calculation tasks: 4
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: 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: 20  
laboratory exercises: 10  
calculation tasks: 0  
seminar works: 30  
project design: 0  
final exam: 30  
requirements to take the exam (number of points): 35  

**references**  
Robert L. McCoy, Modern Exterior Ballistics, 1999 AIAA, USA  
M.Milinovic missile szstems design, eng, Univ.of Belgrade ,FME,layhandout,2000.
Skill Praxis B - SIN

ID: MSc-1217
responsible/holder professor: Micković M. Dejan

level of studies: B.Sc. (undergraduate) academic studies
ECTS credits: 1
final exam: written

parent department: weapon systems

goals

The course teaches the student to approach the practical activities of engineers through the practical work. The student gains an opportunity to apply into practice the knowledge and skills obtained by studying the theory. By that way students would gain insight into the technical and organizational aspects of work and their mutual relationship in companies or institutions.

learning outcomes

Students will acquire practical knowledge in the field of weapons systems related to the fundamentals of design, the main production technologies, the organization of work, methods of product testing and the like.

theoretical teaching

The role and importance of professional practice in the field of weapons systems. Measures of health and safety at work in the field of explosive materials, weapons and military equipment. The basic principles of design, construction and production of weapons systems. Control and testing. Introduction to the professional practice. Guidelines on how to best use the time in companies. Instructions for keeping a diary.

practical teaching

Practical work can be done in
• military industry enterprises,
• scientific and research institutions focused on research and development of weapons systems,
• other companies.

In the military industrial enterprises, students should be concentrating on the domestic defense industry products, as well as the technologies used in the production of weapons systems.
In the scientific and research institutions students should be focused on a systematic approach to problems of design and testing of weapons systems.
In other companies, students should be focused on specific production technologies, issues of organization, as well as the production process and product quality control.

prerequisite

Ne.

learning resources
number of hours

total number of hours: 90

active teaching (theoretical)

lectures: 0

active teaching (practical)

auditory exercises: 0
laboratory exercises: 40
calculation tasks: 0
seminar works: 20
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: 5
check and assessment of projects: 0
colloquium, with assessment: 0
test, with assessment: 0
final exam: 20

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): 35

references