SYLLABUS

Course information (basic description, general information, teaching overview, required equipment and preparation, etc.)

**Workload:** 35 L + 40 S + 30 P

**Course objectives:**
Acquiring the knowledge of chemical compounds - both inorganic and organic - that constitute living cells or are used in their synthesis, of chemical processes that arise during their transformations, of electrochemical processes, chemical kinetics and thermochemistry. Acquiring the capability to apply that knowledge on biological systems, which is important for understanding the human metabolism, both in physiological and pathological conditions.

**Development of general and specific competences (knowledge and skills):**
Developing awareness of the similarity and inseparability of chemical reactions within living and non-living matter, the relationship between structure and reactivity, chemical and energetic transitions, the laws of thermodynamics. Developing skills to use acquired knowledge for understanding the biochemical reactions in human organisms. Expanding the knowledge on relations between the structure and physical/chemical properties of matter based on simple molecules and applying it to biomolecules. Solving numerical and logical problems from the field of Medical Chemistry and Biochemistry. Developing skills necessary for experimental work, mastering the basic laboratory techniques and methods (chromatography, optical methods, pH-measurement). Encouraging students to apply information technology and use scientific literature. Building a sense of teamwork and developing their ability of creative and critical thinking needed for drawing conclusions based on data obtained through analysis. Developing methods and skills necessary for the presentation of obtained results.

**Course correlativity and correspondence:**
The content of the course Medical Chemistry and Biochemistry I correlates with and is complementary to the following courses: Medical Physics and Biophysics, Biochemistry II.

**Approaches to teaching and learning:**
Lectures, seminars, numerical and laboratory practicals.

Assigned reading:
B. Blagović and M. Tota (Eds.): Handbook for Seminars and Laboratory Practicals in Medical Chemistry and Biochemistry I, Faculty of Medicine, University of Rijeka, Rijeka, 2019;

Course teaching plan:
The list of lectures (with the titles and learning outcomes):

• Explain the classification of matter.
L2 Water and Water Solutions.
• Provide the basic facts about the quantity, distribution and the role of water in the body.
• Explain the structure and properties of water.
• Explain the dissolution of gasses and solid compounds in water.
L3 Solutions of Electrolytes.
• Distinguish electrolytes and nonelectrolytes.
• Explain the properties of solutions of acids, bases, ampholytes and salts.
L4 Colligative Properties.
• Define the principle of colligative properties.
• Explain vapour-pressure lowering, freezing point depression and boiling point elevation.
L5 Colligative Properties. Colloids.
• Explain osmosis and dialysis. Define osmotic pressure.
• Explain colloids.
• Name and describe the types and properties of colloids.
• Explain the difference between the sol and gel state of colloids.
• Explain the principle of Donnan equilibrium.
• Describe electrophoresis.
• Describe the role of chelation in biological systems.
• Explain the effect of chelators and their use in medicine.
• Explain the principles of the complexometric method.
• Relate the structure and properties of apatite minerals (hydroxyapatite, fluorapatite).
L7 Chemical Kinetics. Rate, Order and Molecularity of Reaction.
• Define the basic principles of chemical kinetics.
• Define the rate of reaction and reaction order.
L8 Factors Affecting the Rate of Reaction. Catalysis.
• Explain how various factors affect the rate of reaction.
• Describe the mechanism of action of catalysts.
• Explain the difference between chemical and biochemical catalysts.
L9 Chemical Equilibrium
• Describe the law of mass action and the equilibrium constant.
• Define Le Chatelier's principle.
• Explain the impact of external factors on equilibrium.
L10 Chemical Equilibrium.
- Define the equilibrium of homogeneous and heterogeneous systems and electrolyte solutions.
- Define Ostwald's dilution law. Define the solubility product.
- Describe calcified tissues and the formation of concrements.
- Distinguish dynamic equilibrium and consistent flow and its importance in biological systems.

- Write the equilibrium constant of the chemical reaction.
- Write and explain hydrolsyis constant.
- Explain the mechanism of buffer action. Write and explain Henderson-Hasselbalch equation.

- Define the basic concepts of thermodynamics and basic thermodynamic quantities.
- Apply the first law of thermodynamics to biochemical systems.

- Explain the effect of ΔG, ΔH, ΔS values on the spontaneity of reaction.
- Relate Gibbs’ energy with the equilibrium constant.

- Explain the structure of the galvanic cell.
- Explain the meaning of standard reduction potential.

- Write down and explain the Nernst equation.
- Name biologically important oxidation-reduction systems.
- Define the standard redox potential of biological systems.
- Explain Gibbs’ energy of redox-systems.

- Classify organic compounds according to functional groups and explain their chemical properties.
- Define the types of reactions of organic compounds.
- Explain the concept of nucleophile and electrophile.

- Explain hybridization.

- Explain resonance and inductive effect.

L19 Isomerism
- Define isomerism. Explain the types of isomerism (structural, positional, stereoisomerism, geometrical isomerism and conformational isomerism).

L20 Stereoisomerism: Optical Isomerism.
- Define the chiral molecules.
- Explain D,L-steric order and R,S-system.

L21 Biologically Important Oxygen Compounds: Alcohols, Phenols and Ethers.
- Explain the chemical properties of these classes of compounds and their reactivity.
- Explain the reactions of oxygen compounds.

L22 Biologically Important Oxygen Compounds: Aldehydes and Ketones.
- Explain the significance of this group of compounds, their chemical properties and their reactivity.

- Define tautomerism.
- Explain aldol condensation.

L24 Carbohydrates
- Explain their structure and chemical properties.

L25 Carbohydrates
- Name and explain the structure of biologically most important monosaccharides, disaccharides and polysaccharides.

L26 Carboxylic Acids and their Derivatives.
The list of seminars with descriptions:

S1,2 Elements and Compounds.
- Explain the structure of atoms, the periodic system and properties of elements that change periodically.
- List the biogenic elements and define their biological role.
- Explain the structure and define the properties of compounds.

S3,4 Chemical Bonds and Intermolecular Forces
- Explain and identify chemical bonds and intermolecular forces.

S5 Acids and Bases
- Define acids and bases according to Arrhenius, Brønsted and Lewis.

S6,7,8,9 Salts. Hydrolysis. Buffers
- Define simple salts. Write equation of neutralisation.
- Explain the hydrolysis of salts.
- Define buffers and explain the mechanism of buffer action.

S10 Solutions. Solution Concentration.
- Define the concept of mole and the concentration of solutions (fractions, molar and mass...
• Concentration, molality.

• Define intensive and extensive properties.

• Solve the exercises with concentrations.

S11,12 Solution Concentration.

• Solve the exercises with concentrations.

• Define saline solution (physiological solution).

S13,14 Colligative Properties (Lowering of Vapour Pressure, Elevation of Boiling Point, Depression of Freezing Point and Osmotic Pressure)

• Define colligative properties.

• Solve exercises relating colligative properties.

S15,16 Equilibrium in the Solutions of Weak Electrolytes. Dissociation Constants of Acids and Bases. The Ionic Product of Water. pH.

• Define and write down the dissociation constants of acids and bases.

• Explain the ionisation of water and define the ionic product of water. Define pH.

• Define the pH of body fluids.

S17,18 Equilibrium in the Solutions of Weak Electrolytes. Numeric Exercises

• Solve exercises using pH, the ionic product of water and dissociation constants.

S19,20 Reactions of Organic Compounds

• Describe the characteristic reactions of organic compounds.

S21,22 Hydrocarbons

• Classify and name hydrocarbons.

• Write down the characteristic reactions of hydrocarbons and aromatic compounds.

S23,24 Alcohols, Ethers, Phenols and Thiols

• Explain the chemical properties and reactivity of these groups of compounds.

• List biologically important representatives.

S25 Amines

• Explain the chemical properties and reactivity of this group of compounds.

• List biologically important representatives.

S26,27,28 Aldehydes and Ketones

• Explain the chemical properties and reactivity of these groups of compounds.

S29,30 Monosaccharides and Disaccharides

• List biologically important representatives.

• Explain the formation of cyclic form.

• Explain the reactivity of monosaccharides and specify their stereoisomers.

S31,32 Carboxylic Acids and their Derivatives

• Explain the chemical properties and reactivity of these compounds.

S33,34 Substituted Carboxylic Acids

• Name and define substituted carboxylic acids (halogen-, oxo-, hydroxy-, amino acids).

• Explain their chemical properties.

S35,36 Lipids. Fatty Acids.

• Explain the physical properties of lipids.

• Define fatty acids and name important biological representatives.

• Explain the chemical properties of fatty acids.

S37 Amino Acids

• Define chemical properties and general reactions.

• Classify amino acids.

• Define and calculate the isoelectric point of amino acids.

S38,39 Peptides.

• Explain the principles of synthesis and determination of sequence.

• List the physiologically active peptides.

• List the methods of protein chemistry.
The list of numerical and laboratory practicals (NP) and laboratory practicals (LP) with short explanations:

  |  | Basic chemistry lab equipment and techniques.  
  |  | Detection and identification of different cations and anions in a solution.  
  |  | Detection and identification of cations and anions in salt solutions.  
  | LP2 (3 h) | Quantitative Chemical Analysis.  
  |  | Name the main types of quantitative chemical analysis.  
  |  | Describe and exemplify the volumetric methods.  
  |  | Volumetric analysis.  
  |  | Employ the alkalimetric, manganometric and complexometric methods.  
  | NP1,2 (2 h) | Chemical Kinetics  
  |  | Describe the influence of temperature, concentration, pH and catalyst on the rate of oxidation of oxalic acid with potassium permanganate.  
  |  | Solve numerical exercises.  
  | LP3 (2 h) | Chemical Kinetics.  
  |  | Investigate experimentally the influence of temperature, concentration, pH and catalyst on rate of reaction.  
  | NP 3,4 (2h) | pH and Buffer Solutions.  
  |  | Describe the mechanism of buffer action in body fluids.  
  |  | Calculate the pH value of buffer solutions.  
  | NP 5,6,7 (3h) | Redox Reactions.  
  |  | Define the oxidant and reductant in redox reactions.  
  |  | Balance the redox reactions.  
  | LP4 (2 h) | Buffer Solutions.  
  |  | Prepare the phosphate buffer solution.  
  |  | Measure the pH and buffer capacity.  
  | LP5 (3 h) | Qualitative Organic Analysis  
  |  | Detect and identify functional groups.  
  |  | Detect and identify amides and purines in solution.  
  | LP6 (4 h) | Optical Methods  
  |  | Spectrophotometry.  
  |  | Determine the wavelength of maximum absorbance.  
  |  | Determine the influence of a concentration on absorbance.  
  |  | Determine the concentration of CuSO₄ in a solution using a spectrophotometer.  
  |  | Polarimetry.  
  |  | Determine the specific rotation angle of sugar.  
  |  | Make a calibration graph using sugar solutions with different concentrations.  
  |  | Determine the mass concentration of sugar in a sample by measuring the angle of rotation.  
  |  | Determine the isoelectric point of a given protein solution.  
  |  | Perform a TLC for a given amino acids mixture.  
  |  | Quantitatively determine the concentration of serum proteins using the Biuret method.  

Students’ obligations:

Class attendance including test attendance is mandatory. Students may be absent from 30% of each form of teaching provided they have a justifiable cause. Absence from laboratory practicals is obligatory compensated by an oral colloquy.

Assessment of students’ work:

Students can obtain a total of 100 credits: a maximum of 70 credits during the course of the semester (writing three midterm exams and on laboratory practicals) and a maximum of 30 credits on the final exam. Students are allowed to take the final exam if they gain a minimum of 35 credits during the semester.

At all written and oral exams, the student must give at least 50% of the correct answers. Students who did not obtain 50% on each midterm may once retake the midterms, which will be held during the final exam period.

Students who are not satisfied with the obtained credits are also allowed to retake their midterm exams, but thereafter only the credits gained from the retaken midterms will be considered.

Exam (exam taking, detailed exam description of the oral/written/practical part, point distribution, grading criteria):

Evaluation of students’ progress during classes, midterms and the final exam is shown in Table 1.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>CREDITS</th>
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<td>Midterm exams</td>
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<tr>
<td>I General and inorganic chemistry</td>
<td>17 (x score)</td>
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<td>II Stoichiometry</td>
<td>11 (x score)</td>
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<tr>
<td>III Organic chemistry and biochemistry</td>
<td>28 (x score)</td>
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<td>Final exam</td>
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<td>Written exam</td>
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<td>Oral exam</td>
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<td>Total</td>
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<td>TOTAL</td>
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Midterm exams:

Three midterm exams will be held during the semester. The first one covers the content of bioinorganic, general and physical chemistry, the second one covers stoichiometry and the third one covers organic chemistry and biochemistry (theory, nomenclature and structural formulas).

Laboratory practicals:

Students can gain a maximum of 14 credits through 7 laboratory practicals. Each completed practical brings 2 credits: 1 for successfully executed laboratory work and 1 for a completed written report after each practical. Grading of the laboratory work will be made based on the initial written test (5 short questions; student with 2 or less correct answers will not be allowed to attend the practical), activity during work and laboratory skills. For each exercise, a report must be written and submitted in due time. The mistakes, if any, must be corrected upon resubmission, which takes place together with a following report. Only one correction is allowed and the grading of the report will be done upon it. Grading will be based primarily on the quality of the initial report (accuracy and neatness), but if the corrections are not addressed in an appropriate matter or in a given deadline, the report will be graded 0. If more than 30 % of laboratory work or 30 % of reports are graded 0, or if the total sum of all practicals’ credits is less than 7 (i.e. 50 % of total practicals’ credits), the student will not be allowed to take the final exam. An absence (for any reason) from a laboratory practical must be compensated by an oral colloquy within a week from the practical; successful colloquy brings a total of 0,5 credits. Retakes of the colloquy will not be allowed.

Final exam:

The final exam comprises a written exam (15 credits) and an oral exam (15 credits). Students are required to pass both parts of the final exam.
Assessment of the oral part of the final exam:
7.5 – 8 credits: minimum criteria satisfied
9 – 11 credits: average criteria satisfied with noticeable errors
12 – 13 credits: answer with a few errors
14 – 15 credits: outstanding answer.

The ECTS grading system is defined by the following criteria:
A (5, excellent) 90-100 credits
B (4, very good) 75-89.99 credits
C (3, good) 60-74.99 credits
D (2, sufficient) 50-59.99 credits
F (1, insufficient, fail) less than 50 credits

Other important information regarding the course:

Retaking the course:
A student who gains less than 35 credits during the pre-exam period, has failed the course.
**COURSE SCHEDULE (for academic year 2020/2021)**

<table>
<thead>
<tr>
<th>Date</th>
<th>Lectures (Time), Lecture Hall*</th>
<th>Seminars (Time) Seminar Group, Lecture Hall**</th>
<th>Laboratory Practicals (Practicum at the Department)</th>
<th>Lecturer</th>
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<tbody>
<tr>
<td>Thu 01/10/2020</td>
<td>L 1 (12:15-13:00), LH1</td>
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<td>Assoc. Prof. G. Čanadi Jurešić</td>
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<td>Fri 02/10/2020</td>
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<td>S 1,2 (08:15-10:00) SG1, LH 7</td>
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<td>Assist. Prof. L. Batičić</td>
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<td><strong>1st Week</strong></td>
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<td>Wed 07/10/2020</td>
<td>L 2,3 (10:15-12:00), LH8</td>
<td>S 3,4 (12:15-14:00) SG1, LH 4</td>
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<td>Fri 09/10/2020</td>
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<td>Tue 13/10/2020</td>
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<td>S 7,8 (8:15-10:00) SG2, LH 4</td>
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<td>Wed 14/10/2020</td>
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<td>Thu 15/10/2020</td>
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<td>S 9,10 (8:15-10:00) SG2, LH8</td>
<td>LP 1 (12:15-15:00) G1</td>
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<td>Fri 16/10/2020</td>
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<td>Thu</td>
<td>12/11/2020</td>
<td>S 17,18 (8:15-10:00), SG2, LH8 S 17,18 (13:15-15:00) SG1, LH4</td>
<td>Assist. Prof. D. Klepac</td>
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<td>LP 3 (13:00-15:00) G3 LP 3 (15:00-17:00) G2</td>
<td>Assist. Prof. L. Batičić</td>
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<td>Fri</td>
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<td>19/11/2020</td>
<td>NP 5,6,7 (8:15-10:30) SG2,LH4 NP 5,6,7(14:15-16:30) SG1,LH4</td>
<td>Assist. Prof. D. Klepac</td>
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<td>Assist. Prof. M. Pešković Didović</td>
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<td>Assist. I. Vukelić</td>
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<td>Fri</td>
<td>20/11/2020</td>
<td>LP 4 (08:00-10:00) G1, G2 LP 4 (10:00-12:00) G3 LP 4 (12:00-14:00) G4, G5</td>
<td>Assist. I. Vukelić</td>
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<td>Assist. Prof. L. Batičić</td>
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<td>8th Week</td>
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<tr>
<td>Tue</td>
<td>24/11/2020</td>
<td>L14,15 (12:15-14:00), LH1</td>
<td>Assoc. Prof. Marin Tota</td>
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<tr>
<td>Wed</td>
<td>25/11/2020</td>
<td>L16-18 (10:15-13:00), H15</td>
<td>Assist. Prof. L. Batičić</td>
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<td>Fri</td>
<td>27/11/2020</td>
<td>S 19,20 (08:15-10:00) SG2, LH8 S 19,20 (10:15-12:00) SG1, LH8</td>
<td>Assist. Prof. L. Batičić</td>
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<td>9th Week</td>
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<tr>
<td>Mon</td>
<td>30/11/2020</td>
<td>1st Midterm Exam (14:15-16:00),</td>
<td>Assoc. Prof. G. Čanadi Jurešić</td>
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<tr>
<td>Wed</td>
<td>2/12/2020</td>
<td>L 19,20 (10:15-12:00), LH8</td>
<td>Assoc. Prof. G. Čanadi Jurešić</td>
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<tr>
<td>Thu</td>
<td>3/12/2020</td>
<td>S 21,22 (08:15-10:00) SG2, LH4 S 21,22 (11:15-13:00) SG1, LH4</td>
<td>Assist. Prof. L. Batičić</td>
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<td>Instructor</td>
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| Fri  | 4/12/2020  | S 23,24 (08:15-10:00) SG1, LH7  
S 23,24 (13:15-15:00) SG2, LH7 | Assist. Prof. D. Klepac |
| **10th Week** | | | |
| Wed  | 09/12/2020 | L 21,22 (10:15-12:00), LH15 | Assoc. Prof. G. Čanadi Jurešić |
| Thu  | 10/12/2020 | S 25,26 (08:15-10:00) SG2, LH4  
LP 5 (12:00-15:00) G1, G2  
LP 5 (13:00-16:00) G3, G4 | Assoc. Prof. G. Čanadi Jurešić  
Assist. I. Vukelić  
Assist. Prof. L. Batičić  
Assist. Prof. M. Petković Didović  
Assist. Prof. D. Klepac |
| Fri  | 11/12/2020 | S 25,26 (08:15-10:00) SG1, LH4  
LP 5 (08:00-11:00) G5 | Assoc. Prof. L. Batičić |
| **11th Week** | | | |
| Mon  | 14/12/2020 | **2nd Midterm Exam**  
(16:00), | |
| Wed  | 16/12/2020 | L 23,24,25 (10:15-13:00), LH8 | Assoc. Prof. G. Čanadi Jurešić |
| Thu  | 17/12/2020 | S 27,28 (08:15-10:00) SG2, LH4  
S 27,28 (11:15-13:00) SG1, LH4 | Assoc. Prof. G. Čanadi Jurešić |
| Fri  | 18/12/2020 | S 29,30 (08:15-10:00) SG1, LH5  
S 29,30 (13:15-15:00) SG2, LH6 | Assoc. Prof. G. Čanadi Jurešić |
| **12th Week** | | | |
| Wed  | 23/12/2020 | L26,27 (10:15-12:00), LH1 | Assist. Prof. L. Batičić |
| **13th Week** | | | |
| Thu  | 07/01/2021 | L 28,29 (13:15-15:00), LH1 | Assoc. Prof. G. Čanadi Jurešić |
| | | S 31,32 (08:15-10:00) SG 2, LH6  
S 31,32 (11:15-13:00) SG1, LH5 | Assoc. Prof. L. Batičić  
Assist. Prof. L. Batičić |
| Fri  | 8/01/2021  | S 33,34 (08:15-10:00) SG2, LH5  
S 33,34 (10:15-12:00) SG1, LH5 | Assist. Prof. L. Batičić |
| **14th Week** | | | |
| Tue  | 12/1/2021  | S 35,36,37 (12:15-15:00) SG2, LH8 | Assoc. Prof. G. Čanadi Jurešić |
| Wed  | 13/1/2021  | L 30-32 (8:15-11:00), LH1 | Assoc. Prof. G. Čanadi Jurešić/ Prof. J. Varljen |
| Thu  | 14/1/2021  | LP 6 (12:00-16:00) G1, G2  
LP 6 (13:00-17:00) G3, G4 | Assoc. Prof. M. Petković Didović  
Assist. I. Vukelić  
Assist. Prof. L. Batičić  
Assist. Prof. D. Klepac |
<table>
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<tr>
<th>Day</th>
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<th>Time</th>
<th>Lecture Hall</th>
<th>Instructor(s)</th>
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<td>Wed</td>
<td>20/1/2021</td>
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<td>L 33-35 (10:15-13:00), LH15</td>
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<td>Assist. Prof. M. Petković Didović, Prof. J. Varljen</td>
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<td>Thu</td>
<td>21/1/2021</td>
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<td>S 38,39 (08:15-10:00) SG2, LH7</td>
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<td>Assoc. Prof. G. Čanadi Jurešić</td>
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<td>Fri</td>
<td>22/1/2021</td>
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<td>LP 7 (8:00-11:00) G5</td>
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<td>Assist. Prof. L. Batičić</td>
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* 3rd Midterm Exam
(12:15-14:00), 2 and 15

* *  

* Note: In the winter semester of AY 2020/21. due to the epidemiological situation, lectures (and seminars) will be performed online. In the case of on-site classes, lecture halls or practicals as scheduled will be used. Any change in schedule, made by course coordinator, will be notified in advance.

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<tr>
<th>Midterm</th>
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<th>Lecture Hall</th>
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<td>III</td>
<td>22/1/2021</td>
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**FINAL EXAM**

1. 4.2.2021.
2. 18.02.2021.
3. 5.7.2021.
4. 2.9.2021.