<table>
<tr><td>NAME OF THE COURSE</td><td colspan="5">Analytical methods</td></tr>
<tr><td>Code</td><td>PMC223</td><td>Year of study</td><td colspan="3">2.</td></tr>
<tr><td>Course teacher</td><td>Ivana Mitar, assistant professor</td><td>Credits (ECTS)</td><td colspan="3">4.0</td></tr>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2"></td><td rowspan="2">Type of instruction (number of hours)</td><td>L</td><td>S</td><td>E</td><td>F</td></tr>
<tr><td>30</td><td>15</td><td>30</td><td></td></tr>
<tr><td>Status of the course</td><td>mandatory</td><td>Percentage of application of e-learning</td><td colspan="3">10 %</td></tr>
<tr><td colspan="6">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="5">Understanding of basic principles and application of classical methods of qualitative and quantitative analysis of substances and basic instrumental methods.</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="5">Completed course Basic and Inorganic Chemistry.</td></tr>
<tr><td>Learning outcomes expected at the level of the course (4 to 10 learning outcomes)</td><td colspan="5">Upon completion of the course, students will be able to:
1. Define the basic concepts of analytical chemistry Distinguish between quantitative and qualitative analysis,
2. Explain the physical and chemical principles of each method of classical analysis,
3. Participate in the selection of the appropriate analytical method depending on the nature of the sample to be analyzed,
4. Understand acid-base, complement, precipitation, redox reactions and
5. Participate in the calculation, explanation, and interpretation of analytical results.</td></tr>
<tr><td>Course content broken down in detail by weekly class schedule (syllabus)</td><td colspan="5">LECTURES:

1. Definition, importance, and classification of analytical chemistry
Chemical analysis: qualitative and quantitative, physical methods of analysis, instrumental methods of analysis); analytical process (problem definition, sampling, choice of analytical methods, analytical signal, report); safety of laboratory work; concept and definition of chemical analysis: qualitative and quantitative.
2. Heterogeneous and homogeneous systems
Chemical equilibrium (equilibrium constants: thermodynamic, concentration, conditional); quantitativity of reactions.
3. Acid-base equilibria
Acid and base strength (α-value); autoprotolysis of water.
4. Activity and activity coefficient
Ionic strength of the solution.
5. Acid-base buffer
Buffer preparation; buffer capacity.
6. Salt hydrolysis
Acidity and basicity of salts; hydrolysis constant.
7. Quantitative chemical analysis: titrimetric methods of analysis
Titration, equivalence point, end point; primary and secondary standards; standardization of solutions; indicators; titration curves.
8. Acid-base titrations</td></tr>
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	Primary and secondary acid-base titration standards; acid-base indicators; titration curves (calculation of pH during titration). 9. Equilibria of complex formation Individual and sum constants of stability of complexation; ligands; complexometric titrations with EDTA, Y^{4-}; complexometric indicators. 10. Equilibrium between a solid, poorly soluble substance and its ions Precipitation and dissolution reactions (solubility, solubility product constant); titrations based on precipitation equilibria. 11. Quantitative chemical analysis: gravimetric methods Properties of precipitation reagents (specific, selective, organic, inorganic); types of precipitate; gravimetric factor. 12. Oxidation-reduction equilibria Standard electrode potential, electrode potential, Nernst equation; equilibrium constants of oxidation-reduction reactions, titrations based on reduction-oxidation equilibria. 13. Electroanalytical methods Potentiometry; electrogravimetry 14. Introduction to instrumental analysis: Spectroscopy Basic principles of UV / VIS and IR spectroscopy. 15. Chromatography Basic principles of surface and column chromatography (HPLC, GC). SEMINAR: Solving numerical examples related to the theoretical material covered. EXERCISE**:** 1. Basic actions in the laboratory of quantitative chemical analysis 2. Basic principles of solution preparation and safety in the laboratory 3. Preparation of solutions for quantitative analysis 4. Preparation of buffer solutions 5. Hydrolysis of salts 6. Standardization of titrants: hydrochloric acid and sodium hydroxide 7. Alkalimetry: determination of ascorbic acid 8. Complexometry: determination of water hardness 9. Methods based on precipitation reactions: determination of chloride ions according to Mohr method 10. Methods based on redox reactions: determination of ascorbic acid 11. Electrogravimetric separation of copper and nickel in the sample 12. Spectrophotometric determination of copper 13. Spectrophotometric determination of iron 14. Pigment analysis by IR spectrophotometry 15. Exercise review	
Format of instruction	x lectures x seminars and workshops ☐exercises ☐ *on line* in entirety ☐ partial e-learning ☐ field work	☐ independent assignments ☐ multimedia x laboratory ☐ work with mentor ☐ (other)
Student responsibilities	Students are required to attend classes (lectures and seminars 80 %, laboratory practice 100 %) and actively participate in the teaching process. That will be recorded and evaluated in making a final assessment.	

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<tr><td rowspan="6">Screening student work (name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)</td><td>Class attendance</td><td>0.5</td><td>Research</td><td></td><td>Practical training</td><td>1</td></tr>
<tr><td>Experimental work</td><td></td><td>Report</td><td></td><td colspan="2">(Other)</td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td></td><td colspan="2">(Other)</td></tr>
<tr><td>Tests</td><td></td><td>Oral exam</td><td>1</td><td colspan="2">(Other)</td></tr>
<tr><td>Written exam</td><td>1.5</td><td>Project</td><td></td><td colspan="2">(Other)</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Grading and evaluating student work in class and at the final exam</td><td colspan="6">All laboratory exercises must be completed. The grade for the laboratory exercises will be based on the laboratory work. The final grade for the course will consist of a written (seminar) and an oral part (lecture) and laboratory examination. The written part may be taken in whole or in part by partial examinations during the semester. The exams will be graded as follows:
more than 60 % - adequate,
more than 70 % - good,
more than 80 % - very good and
more than 90 % - excellent.
The oral part of the examination is taken by the students after successfully passing the written examination (partially or completely).</td></tr>
<tr><td rowspan="4">Required literature (available in the library and via other media)</td><td colspan="3">Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="3">1. D. A. Skoog, D. M. West, F. J. Holler and S. R. Crouch, Fundamentals of Analytical Chemistry, 9th Edition, Thompson Brooks/Cole, Belmont, USA, 2014.</td><td>10</td><td></td></tr>
<tr><td colspan="3">2. I. Mitar, Laboratory exercises for courses in analytical chemistry, internal, unlicensed script.</td><td></td><td></td></tr>
<tr><td colspan="3"></td><td></td><td></td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="6">1. R. Kellner, J. M. Mermet, M. Otto, M. Valcarcel and H. M. Widmer, Analytical Chemistry (A Modern Approach to Analytical Science, Second Edition) Wiley-VCH, Verlag Gmbh & Co. KGaA, Weinheim, 2004.
2. D. C. Harris, Quantitative Chemical Analysis, W. H. Freeman and Company, 41 Madison Avenue New York, NY, 2016.
3. B. M. Tissue, Basic of Analytical Chemistry and Chemical Equilibria, John Wiley & Sons, Inc., Hoboken, New Jersey, NY, 2013.
4. G. D. Christian, P. K. Dasgupta, K. A. Schug, Analytical Chemistry, John Wiley & Sons, Inc., 111 River Street, Hoboken, New Jersey, NY, 2014.</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="6">Quality of the teaching and learning, monitored at the level of the (1) teachers, accepting suggestions of students and colleagues, and (2) faculty, conducting surveys of students on teaching quality.</td></tr>
<tr><td>Other (as the proposer wishes to add)</td><td colspan="6"></td></tr>
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