<table>
<tr><td rowspan="3"></td><td colspan="2">University of Belgrade
Technical Faculty in Bor
Vojske Jugoslavije 12, 19210 Bor</td><td rowspan="3"></td></tr>
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BOOK OF COURSES

STUDY PROGRAM: **TECHNOLOGICAL ENGINEERING**

DOCTORAL ACADEMIC STUDIES

(3RD LEVEL OF THE ACADEMIC STUDIES)

Bor, 2023.

List of courses:

Course: Mass transport phenomena

Lecturer/s: Snežana M. Šerbula PhD, Full professor, Snežana Milić PhD, Full professor

Status of the course: Elective course for the Technological engineering study program.

ECTS: 15

Prerequisite: Required knowledge in the field of the phenomena of movement, heat and mass transfer.

Course goals: The aim of the course is for students to learn the basic transport mechanisms in diffusion and mass transfer.

Learning outcomes: Students are trained to independently make calculations and predictions of possible outcomes of the process of mass transfer phenomena that will appear as a subject of research.

Course description:

Lectures:

Diffusivity and mass transfer mechanisms. Theory of diffusion in gases. Assessment of diffusivity in liquid. Mass transport by convection. Diffusion with heterogeneous chemical reaction. Equations for entropy and heat flux in mass transfer. Mass transfer across selectively permeable membranes. Osmosis. Mass transfer in porous media. Absorption followed by a chemical reaction in the liquid phase. Catalyzed interphase transfer. Mass transfer in biological systems. Biosorption and phytosorption. Bioextraction and phytoextraction.

Literature:

Recommended:

1. Bird R.B., Stewart E.W., Lightfoot N.E., Transport Phenomena, Second Edition, John Wiley & Sons, Inc. 2002.
2. Welty J.R., Wicks C.E., Wilson R.E., Rorrer G.L.; Fundamentals of Momentum, Heat, and Mass Transfer 5th Edition, John Wiley & Sons, Inc. 2007
3. Cvijović S., Bošković-Vragolović N., Fenomeni prenosa-strujanje, toplota, difuzija, TMF, Beograd, 2006
4. A. Duduković, Osnovi operacije prenosa mase, TMF, Beograd, 2018.

Ancillary:

5. Using literature from available databases (SCOPUS, Web of Science, SciFinder, MEDLINE, INIS, etc.)

Number of classes per week	Lectures: 6	Practical classes: 4

Teaching methods: Method of oral presentation and discussion, method of written papers (seminar work).

Knowledge evaluation (maximum 100 points)

Oral exam 30% + preparation of the seminar paper 50% + defense of the seminar paper 20%

Course: Selected topics of Chemical Thermodynamics
Lecturer/s: Snežana M. Šerbula PhD, Full professor, Jelena M. Djoković PhD, Full professor, Vesna Krstić PhD, Senior research associate
Status of the course: Elective for the Technological Engineering study program
ECTS: 15
Prerequisite: Required knowledge of thermodynamics
Course goals: The aim of the course is to introduce doctoral students in detail to the modern definition of terms related to systems studied within the framework of inorganic chemical technology. Estimation of the equilibrium composition, analysis and using of phase diagrams, prediction and calculations of thermodynamic parameters of interest for designing technological processes, establishing and determining the energy and mass balance. Special importance is given to thermodynamic calculations.
Learning outcomes: Students are trained to independently perform thermodynamic calculations and predictions of possible outcomes of processes that will appear as the subject of research.
Course description: Lectures: Modern definitions of quantities and functions in chemical thermodynamics. Basic equations and Maxwell's relations in variable and non-variable force fields (electrical, magnetic and gravitational) with consideration of surface effects of phases. General criteria for stability of equilibrium in material systems. Methods of calculating the equilibrium composition in simple and complex chemical equilibrium. Changes in thermodynamic functions in chemical reactions in homogeneous and heterogeneous systems. Basics of the theory of phase diagrams with application to two-component and multi-component systems. Reaction amount and reaction yield. Reactions in electrolytes. Selected chapters of electrochemical thermodynamics. Introduction to statistical thermodynamics. Intermolecular forces. Molecular theory. Diffusion in the solid phase, effects of concentration and temperature on the diffusion coefficient. Defects in compounds that differ from stoichiometry or are close to stoichiometry. Practice: Preparation and presentation of the seminar paper.
Literature: Recommended: 1. T.Matsoukas, Fundamentals of Chemical Engineering Thermodynamics with Applications to Chemical Processes, Prentice Hall U.S., 2012. 2. C.B. Alcock, Thermochemical Processes Principles and Models, Butterworth and Heinemann, Oxford, 2001 3. B. S. Bokstein, M. I. Mendelev, D. J. Srolovitz, Thermodynamics and Kinetics in Materials Science, Oxford University Press, 2005 Ancillary: 4. D. Kondepudi, I. Prigogine, Modern Thermodynamics, Wiley, New York, 1998., 5. Prausnitz, J.M., Lichtenthaler, R.N., de Azevedo, E.G. Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd ed., Prentice Hall, New Jersey, 1998 6. Using literature from available databases (SCOPUS, SCIENCEDIRECT, WEB of SCIENCE, PROQUEST, COMPENDEX, etc.).

Number of classes per week	Lectures:6	Practical classes: 4

Teaching methods: Method of oral presentation and discussion, method of written papers (seminar papers).
Knowledge evaluation (maximum 100 points)
Oral exam 30% + preparation of the seminar paper 50% + presentation of the seminar paper 20%

Course: Chemical kinetics – selected topics

Lecturer/s: Snežana M. Milić PhD, Full professor

Status of the course: Elective for the Technological Engineering study program

ECTS: 15

Prerequisites: Necessary knowledge in the field of kinetics.

Course goals: The course goal is to introduce PhD students to kinetics of chemical reactions in some technological process, influential parameters and methods of controlling them.

Learning outcomes: Finishing this course students will be able to study the kinetics of chemical reactions which will enable them to better manage technological processes.

Course description:

Application of kinetic laws to simple chemical reactions. Elements of the kinetic theory of gases. Theory of reaction kinetics. Parameters that define reaction mechanism and rate (concentration of reactants and products, temperature, reaction surface, presence of other substances, hydrodynamic conditions). Determination of the mechanism of chemical reactions. Kinetics of heterogeneous reactions. Chain reactions. Photochemical reactions. Radiation chemistry. Model selection in heterogeneous systems. Examples of topochemical reactions. Non-isothermal kinetics. Isothermal kinetics. Experimental and analytical methods for determining kinetical parameters. Femtosecond spectroscopy. Kinetics of homogenous and heterogeneous catalytic reactions. Autocatalysis. Kinetics of electrochemical reactions – Electrodics.

Literature

Recommended:

1. G. Hammes, Principles of chemical kinetics, Academic press, London, 1996;
2. E. Koch, Non-isothermal reaction analysis, Academic press, London,1977;
3. S.W. Benson,Thermochemical kinetics, Second edition, John Wiley Sons,New York, 1976.;
4. F. Habashi, Kinetics of Metallurgical Processes, Laval University, Quebec, 1999.,
5. E.N. Eremin, The foundations of chemical kinetics, Mir Publishers, Moskow,1979.;
6. R.F. Speyer, Thermal Analysis of Materials, Marcel Dekker, Inc,1994.
7. J. O`M. Bockris, J.K..N. Reddy, Modern Electrochemistry, John Wiley Sons, New York, 1981
8. Use of literature from available databases (SCOPUS, SCIENCEDIRECT, WEB of SCIENCE, PROQUEST, COMPENDEX, etc.).

Number of classes per week	Lectures: 6	Practical classes: 4

Teaching methods: Lectures with interactive discussions, consultations and experimental work.

Knowledge evaluation (maximum 100 points)

Oral exam 30% + preparation of the seminar paper 50% + defense of the seminar paper 20%

Course: Special course in ceramic technology
Lecturer/s: Snežana M. Milić PhD, Full professor, Milan B. Radovanović PhD, Full professor, Lidija Mančić PhD, Principal research fellow
Status of the course: Elective for the Technological engineering study program
ECTS: 15
Prerequisites: Required knowledge of ceramic technology
Course goals: Acquaintance of students with the latest achievements in the field of ceramic materials and technologies for obtaining those materials.
Learning outcomes: It provides students with quality study of ceramic materials as well as the application of these materials in production technologies
Course description: Classic and new ceramic materials. Structure of new ceramic materials. Structural defects. Expansion and elastic deformation of grains. Anisotropy of the structure. Isostatic pressing. Densification and change in particle size. Strength and modulus of elasticity. Densification curves. Sintering, vitrification and crystallization. The phenomenon of surface energy. Recrystallization. Classification of raw materials for classic and contemporary ceramics.
Literature Recommended: 1. Bansal, Narottam P., Handbook of Ceramic Composites, Boston Kluwer Academic Publishers, 2005. 2. Imanaka Yoshihiko, Multilayered Low Temperature Cofired Ceramics (LTCC) Technology, New York Kluwer Academic Publishers, 2005. 3. Bach Hans; Krause Dieter, Low Thermal Expansion Glass Ceramics, Berlin Springer Science & Business Media, 2005. 4. C. Barry Carter, M. Grant Norton, Ceramic Materials: Science and Engineering, Springer, New York, 2013 5. Using literature from available databases (SCOPUS, SCIENCEDIRECT, WEB of SCIENCE, PROQUEST, COMPENDEX, etc.).

Number of classes per week:	Lectures: 6	Practical classes: 4

Teaching methods: Method of oral presentation and discussion, method of written papers (seminar papers).
Knowledge evaluation (maximum 100 points)
Oral examination 30% + Seminars 50% + Seminar presentation 20%

Course: Materials science

Lecturer: Snežana M. Milić PhD, Full professor, Marija Petrović Mihajlović PhD, Associate professor, Lidija Mančić PhD, Principal research fellow

Status of the course: Elective for the Technological engineering study program

ECTS: 15

Prerequisites: Required knowledge in the field of chemical technology.

Course goals: Introducing students to the latest achievements in the field of new materials and technologies of obtaining those materials.

Learning outcomes: After passing the Materials Science exam, doctoral students will have a good foundation for studying the properties and application of new materials, and they will be able to synthesize those materials from different starting substances using modern synthesis procedures.

Course description:
Crystallization, nucleation and grain growth. Liquid crystals. Amorphous state. Solid solutions. Semiconductors and superconductors. High purity metals. Special and superalloys. Silicate melts and glass. Polymers and biomaterials. Obtaining new materials. Chemothermic and chemical vapor phase deposition. Plasma-thermal. Procedures with the use of lasers. Procedures for obtaining ultradisperse and metal amorphous powders. Obtaining composite materials.

Literature
Recommended:

1. R. W. Cahn, The Coming of Material Science, Pergamon – Elsevier, Amsterdam, 2001.
2. M. F. Ashby, D. R. H. Jones, Engineering Materials, Vol 1., Oxvord Butterworth–Heinemann, 2002.
3. M. F. Ashby, D. R. H. Jones, Engineering Materials, Vol 1., Oxvord Butterworth–Heinemann, 1999.
4. L. H.Van Vlak Elements of materials science and engineering, Addison Wesley Publishing Co. 1989, NewYork
5. Knauth, Philippe.; Schoonman, Joop., Nanocrystalline Metals and Oxides: Selected Properties and Applications, Boston Kluwer Academic Publishers, 2002.
6. Use of literature from available databases (SCOPUS, SCIENCEDIRECT, WEB of SCIENCE, PROQUEST, COMPENDEX, etc.).

Number of classes per week	Lectures: 6	Practical classes: 4

Teaching methods: Method of oral presentation and conversation, method of written papers (seminary work).

Knowledge evaluation (maximum 100 points)

Oral exam 30% + preparation of the seminar paper 50% + defense of the seminar paper 20%

Course: Electrochemical technology
Lecturer/s: Milan B. Radovanović PhD, Full professor, Marija B. Petrović PhD, Associate professor, Jasmina Stevanović PhD, Principal research fellow, Miroslav Pavlović PhD, Senior research associate
Status of the course: Elective for the Technological Engineering study program
ECTS: 15
Prerequisite: Required knowledge in the field of electrochemistry
Course goal: Students will acquire a solid foundation for understanding fundamental electrochemical processes as well as their applications.
Learning outcome: Students will be able to apply electrochemical methods in technological processes using different electrolytes and electrode materials in order to obtain inorganic and organic compounds. The acquired knowledge will be useful for a better understanding of the operation of galvanic current sources and the application of various components for anodes or cathodes in those processes.
Course description: Theoretical foundations of electrochemical processes. Processes on electrodes. Materials for anodes and cathodes. Insoluble and soluble electrodes. Electrolytes. Solvents. Mediators. Diaphragms and membranes. Electrochemical reactors. Electrochemical synthesis of inorganic and organic compounds. Galvanic current sources.
Literature: Recommended: 1. A. Despić, Osnovi elektrohemije, Zavod za udžbenike i nastavna sredstva, Beograd, 2002. 2. Bockris, J. O'M.; Reddy, Amulya K. N.; Gamboa-Aldeco, Maria, Modern Electrochemistry. Volume 1, Ionics , New York Kluwer Academic Publishers, 2002, 3. Bockris, J. O'M.; Reddy, Amulya K. N., Modern Electrochemistry. Volume 2B, Electrodics in Chemistry, Engineering, Biology and Evironmental Science, New York Kluwer Academic Publishers, 2000., 4. Christensen, P. A.; Hamnett, A., Techniques and Mechanisms in Electrochemistry, New York Kluwer Academic Publishers, 1994, 5. Popov, K. I.; Djokic, Stojan S.; Grgur, Branimir N., Fundamental Aspects of Electrometallurgy, New York Kluwer Academic Publishers, 2002., 6. Milchev Alexander, Electrocrystallization: Fundamentals of Nucleation and Growth, Boston, Mass. Kluwer Academic Publishers, 2002. 7. Using literature from available databases (SCOPUS, SCIENCEDIRECT, WEB of SCIENCE, PROQUEST, COMPENDEX, etc.).

Number of classes per week:	Lectures: 6	Practical classes: 4
Teaching methods: Method of oral presentation and discussion, method of written works (seminar work).		
Knowledge evaluation (maximum 100 points)		
Oral examination 30% + Seminars 50% + Seminar presentation 20%		

Course: Fundamentals of corrosion
Lecturer/s: Žaklina Z. Tasić PhD, Associate professor, Ana Simonović PhD, Assistant professor, Miroslav Pavlović PhD, Senior research associate
Status of the course: Elective course for the study program Technological Engineering
ECTS: 15
Prerequisite: Fundamental knowledge in the field of material corrosion
Course goals: Introducing students to the mechanism of corrosion processes and the application of appropriate protection measures. Upgrading basic theoretical knowledge of corrosion phenomena considering recent developments in this field.
Learning outcomes: Students who choose this course will acquire necessary knowledge for studying the phenomenon of corrosion in various materials and environments, particularly methods applied for such examinations.
Course description: Material corrosion. Thermodynamic aspects of corrosion. Corrosion rate. Electrode kinetics. Passivity. Mechanism of corrosion processes. Types of corrosion. Corrosion in different environments. Corrosion inhibitors. Corrosion tests, monitoring, and analysis. Methods for examining corrosion processes. Protection of materials from corrosion.
Literature Recommended: 1. Scully, J.C., The Fundamentals of Corrosion, Pergamon Press, 1990. 2. Fontana, M.G., Corrosion Engineering, McGraw-Hill, New York, 1986. 3. Corrosion Science, The leading international journal in this field. 4. Bardal Einar, Corrosion and Protection, London, New York Springer-Verlag New York, 2004, 5. Perez Nestor, Electrochemistry and Corrosion Science, Boston Kluwer Academic Publishers, 2004. 6. Using literature from available databases (SCOPUS, SCIENCEDIRECT, WEB of SCIENCE, PROQUEST, COMPENDEX, итд.).

Number of classes per week:	Lectures: 6	Practical classes: 4

Teaching methods: Oral presentation and discussion method, written work method (term paper).
Knowledge evaluation (maximum 100 points)
Oral exam 30% + term paper preparation 50% + term paper defense 20%

Course: Environmental protection			
Lecturer/s: Snežana M. Šerbula PhD, Full professor, Slađana Alagić PhD, Full professor			
Status of the course: Elective for the Technological Engineering study program			
ECTS: 15			
Prerequisite: Basic knowledge regarding the environmental pollution and protection			
Course goal: Training students for recognizing the modern definitions of basic terms related to the systems which are investigating in the field of environmental pollution and protection.			
Learning outcome: PhD students are enabled for individual following of actual environmental issues and the assessment of environmental pollution on life.			
Course description: Basic principles on environmental protection. Hazardous substances and their toxicity. Monitoring. Remediation technologies. Natural and anthropogenic polluters. Air quality and methods for air treatment. Water quality and enhanced methods of water treatment. Technologies for soil remediation. Plant uptake of toxic substances. Life cycles of hazardous substances and its degradation.			
Literature Recommended: 1. S.Šerbula, M.Radulović, I.Zafirović, Z.Stanižan, M.Petrović, J.Vukelić, I.Petrović,M.Vesković, ENVIRONMENTAL PROTECTION IN PANČEVO AND BOR, Institute for Sociological Research Faculty of Philosophy University of Belgrade, Belgrade, 2013. 2. Gareth M. Evans, Judith C. Furlong, Environmental Biotechnology, John Wiley & Sons, 2003. 3. Des W. Connell, Basic Concepts of Environmental Chemistry, Taylor & Francis Group, LLC 2005. 4. Snežana M. Šerbula, Air Quality: Aerosols and Biomonitoring, NOVA publishers, New York, 2017. 5. Different data bases (SCOPUS, SCIENCEDIRECT, WEB of SCIENCE, PROQUEST, COMPENDEX, etc). 6. Lichtfouse Eric, Schwarzbauer Jan, Robert Didier, Environmental Chemistry: Green Chemistry and Pollutants in Ecosystems, Berlin, New York Springer Science & Business Media, 2005. 7. Reviews of Environmental Contamination and Toxicology Volumes 180, 181, 184, New York Springer Verlag New York, 2004, 8. Loulou Richard; Waaub Jean-Philippe; Zaccour Georges, Energy and Environment, New York Springer Science & Business Media, 2005, 9. Ruth F. Weiner and Robin Matthews, Environmental Engineering, Butterworth-Heinemann, 2003. Ancillary: 10. Slađana Č. Alagić, Maja M. Nujkić, Snežana B. Tošić, Snežana M. Milić and Mile D. Dimitrijević (**2019**): *Heavy Metal Pollution in the Region of Bor (Serbia) Resulting from the Long-Term Copper Mining and Metallurgical Activities: The Evidence Recorded in Plant Organs and Implications for Biomonitoring and Phytoremediation as Two Prospective Environmentally-Friendly Methods of Pollution Control* in Serbia: Current Issues and Challenges in the Areas of Natural Resources, Agriculture and Environment. Editor: Igor Janev, New York, Nova Science Publishers US, Chapter 13., pp. 301-356.			
Number of classes per week:	Lectures: 6	Practical classes: 4	
Teaching methods: Method of oral presentation and discussion, and method of written work (independent work).			
Knowledge evaluation (maximum 100 points)			
Oral exam 30% + Independent work 50% + Defense of independent work 20%			

Course: Aerosols in the atmosphere
Lecturer/s: Snežana M. Šerbula PhD, Full professor, Tanja Kalinović PhD, Assistant professor
Status of the course: Elective course of the Technological engineering study program.
ECTS: 15
Prerequisite: Required knowledge in the field of air pollution and purification of waste gases.
Course goals: The aim of the course is to make the students of the doctoral academic studies familiar with the modern definition of terms related with the systems which are studied within the framework of atmospheric processes.
Learning outcomes: Students are trained to independently monitor contemporary trends and assess the impact of aerosols in the atmosphere on life cycles.
Course description: Lectures: Definition, types and sources of aerosols. Models of particulate matter transport. Diffusion of aerosols. Aerosol flow models and distribution. Effect of thermal, electrostatic and magnetic force fields. Visibility and light scattering in the atmosphere. Aerosol dynamics: coagulation, nucleation, condensation, crystallization and particle growth. Aerosol sources: combustion of fossil fuels, industry, ambient atmosphere, synthesis of materials, etc.
Literature: Recommended: 1. S. M. Šerbula, Air Quality: Aerosols and biomonitoring, NOVA publishers, New York, 2017. 2. M. Chin, R. A. Kahn, L. A. Remer, H. Yu, D. Rind, G. Feingold, P. K. Quinn, S. E. Schwartz, D. G. Streets, P. De Cola and R. Halthore, Atmospheric Aerosol Properties and Climate Impacts, U.S. Climate Change Science Program, 2009. 3. L. S. Ruzer and N. H. Harley, Aerosols Handbook: Measurement, Dosimetry, and Health Effects, CRC Press, Boca Raton, 2005. 4. W. C. Hinds, Aerosol Technology: Properties, Behavior, and Measurement of airborne particles, Second Edition, John Wiley & Sons, New York, 1999. 5. J. H. Seinfeld, S. N. Pandis, Atmospheric Chemistry and Physics, from Air Pollution to Climate Change, John Wiley & Sons, New York, 1997. 6. Use of literature from available scientific databases (SCOPUS, Web of Science, SciFinder, MEDLINE, INIS, etc.)

Number of classes per week	Lectures: 6	Practical classes: 4

Teaching methods: Interactive teaching and discussion, written papers (seminar work).
Knowledge evaluation (maximum 100 points)
Oral exam 30% + term paper 50% + defense of term paper 20%

Course: Solid waste treatment
Lecturer/s: Ana Simonović PhD, Assistant professor, Ana Radojević PhD, Assistant professor
Status of the course: Elective for the Technological Engineering study program.
ECTS: 20
Prerequisite: Basic knowledge in solid waste management.
Course goals: Upgrading existing knowledge of solid waste management, predominately in the field of solid waste treatment.
Learning outcomes: PhD students will gain the knowledge concerning various types of solid waste treatment, especially about recycling of this kind of waste in order to obtain secondary raw materials and preserve the environment.
Course description: Lectures: Sources, types and composition of solid waste (SW). Physical, chemical and biological properties of the SW. Hazardous waste in the SW. Basic operations in the management of the SW. Physical treatment of the SW. Chemical treatment of the SW. Biological treatment of the SW. Recycling of the SW. Waste disposal. Quality control of sanitary landfill emissions. Sanitary landfills and environmental protection.
Literature: Recommended: 1. F. Woodard, Industrial Waste Treatment Handbook, Boston Butterworth-Heinemann, 2001. 2. Watts, R. J., Hazardous Wastes, John Wiley and Sons, 1980. 3. Tchobanoglous, G., Theisen, H., Vigil, S. A., Integrated Solid Waste Management – Engineering . 4. Principles and Management Issues, McGraw-Hill, New York, 1993. Ancillary: 5. Using literature data from available scientific databases (SCOPUS, SCIENCEDIRECT, WEB of SCIENCE, PROQUEST, COMPENDEX, etc.).

Number of classes per week	Lectures: 6	Practical classes: 4
Teaching methods: Method of oral presentation and discussion, method of written work (term paper).		
Knowledge evaluation (maximum 100 points)		
Oral exam 30% + preparation of term paper 50% + defense of term paper 20%		

Course: Wastewater treatment		
Lecturer/s: Snežana M. Šerbula PhD, Full professor, Grozdanka D. Bogdanović PhD, Associate professor, Maja Nujkić PhD, Assistant professor, Vesna Krstić PhD, Research associate		
Status of the course: Elective for the Technological Engineering study program.		
ECTS: 20		
Prerequisites: Basic knowledge in wastewater technology and treatment.		
Course goals: To provide students with modern knowledge in the field of water treatment and to introduce them to modern processes of industrial wastewater processing.		
Learning outcomes: Students are trained to work independently in the field of water treatment and modern wastewater processing procedures.		
Course description: Categorization of waters and their treatment. Modern methods of wastewater treatment. Physical, chemical and physico-chemical methods of wastewater treatment: adsorption/ion exchange, solvent extraction, flotation procedures, membrane procedures, electrochemical procedures (reduction of metal ions, anodic oxidation of organic compounds, electrodialysis), biochemical methods, hybrid and combined purification procedures. Removal of suspended particles from wastewater - clarification. Treatment and disposal of sludge generated during the processing of industrial wastewater.		
Literature Recommended: 1. N.P. Cheremisinoff; Handbook of Water and Wastewaters Treatment Technologies; N&P Ltd Butterworth and Heinemann; Boston USA 2002. (selected chapters); 2. D. Mara, N.Horan, Handbook of Water and Westwater Microbiology, Academic Press Elsevier, 2003 3. Ch. Comninelis; Technologie Chimique et Biologie de L'environement (selected chapters); SB, EPFL, Swiss 2004. 4. S. Judd and B. Jeffersoon; Membranes for Industrial Wastewaters Recovery and Reuse; Elsevier, 2003 5. Using literature from available databases (SCOPUS, Web of Science, SciFinder, MEDLINE, INIS, etc.)		
Number of classes per week	Lectures:6	Practical classes:4
Teaching methods: Method of oral presentation and discussion, method of term paper.		
Knowledge evaluation (maximum 100 points)		
Oral exam 30% + independent work 50% + presentation of term paper 20%		

Course: Fundamentals of soil remediation

Lecturer/s: Grozdanka Bogdanović PhD, Full professor, Ana Simonović PhD, Assistant professor

Status of the course: Elective for the Technological Engineering study program

ECTS: 20

Prerequisites: Required knowledge in the field of pollution and soil protection.

Course goals: Acquaintance of students with the chemistry of solutions, the interaction of pollutants with soil components and methods of purification of polluted soil. The program will enable students to independently examine the soil and propose appropriate methods of eliminating pollutants.

Learning outcomes : Students will be trained for independent scientific and professional work in this field.

Course description:

Soil chemistry. Soil analysis. Solubility of soil components. Carbonate balance. Reactions of ion exchange in soil. Adsorption processes. Acid-base balance. Redox processes in soil. Inorganic and organic pollutants. Interaction of pollutants with soil components. Remedial technologies. Bioremediation. Chemical oxidation. Thermal desorption. Electrokinetic remediation. Soil washing. Extractive methods of soil purification. Calcification and reduction of salinity. Phytoremediation. Extraction of heavy metals. Other purification techniques.

Literature

Recommended:

1.R.G. Buran and R.J. Zasoski, Soil and water shemistry, U.C. Davis, 2002

2. Rebecca Burt, Soil Survey Laboratory Methods Manual, NRCS, USA 2004,

3. Margesin Rosa, Schinner Franz, Manual for Soil Analysis: Monitoring and Assessing Soil Bioremediation, Berlin, New York Springer Science & Business Media, 2005.

4. Lavelle, P. Spain, Alister V., Soil Ecology, Boston Kluwer Academic Publishers, 2001.

5. Calabrese Edward J.; Kostecki Paul T.; Dragun James, Contaminated Soils, Sediments and Water: Science in the Real World, New York Kluwer Academic Publishers, 2005,

6. Breemen N. van.; Buurman P, Soil Formation, Boston Kluwer Academic Publishers, 2002,

7. Using literature data from available scientific databases (SCOPUS, SCIENCEDIRECT, WEB of SCIENCE, PROQUEST, COMPENDEX, etc.).

Number of classes per week	Lectures: 6	Practical classes: 4

Teaching methods: Method of oral presentation and discussion, method of written work (term paper).

Knowledge evaluation (maximum 100 points)

Oral exam 30% + preparation of term paper 50% + defense of term paper 20%

Course: Intelligent systems for supervision

Lecturer/s: Dr Dejan Tanikić, full professor; Dr Zoran Stević, full professor

Status of the course: Elective course

ECTS: 20

Prerequisite:

Course goals: Introduction to intelligent systems and basic techniques used for designing such systems.

Learning outcomes: Student has acquired theoretical knowledge about the intelligent systems and can apply these systems in support of the supervision and the decision making processes.

Course description:

Lectures:

The basic concept of the artificial intelligence based systems. Characteristics of the intelligent systems. Knowledge representation and ways of drawing conclusions. Knowledge acquisition and learning methods. Using existing data bases. Soft computing techniques. Artificial neural networks. Types of the artificial neural networks. Activation functions and learning algorithms. Fuzzy systems. Methods of the fuzzification of the input variables. Ways of inferencing and de-fuzzification. Hybrid neuro-fuzzy systems. Genetic algorithms. Principles of functioning of the genetic algorithms. Integration of the various soft computing techniques in hybrid systems. Using the intelligent systems for solving specific engineering problems.

Practice:

Practicals. Other forms of teaching. Practical application of the obtained knowledge in accordance with the listed thematic topics.

Literature:

Recommended:

1. W. Pedrycz, Computational Intelligence: An Introduction, CRC Press, 1998.
2. L. C. Jain, N. M. Martin, Fusion of Neural Networks, Fuzzy Systems and Genetic Algorithms: Industrial Applications, CRC Press, 1998.
3. Neural Networks, Algorithms, Applications, and Programming Techniques, Addison-Wesley Publishing Company, Inc., 1991.
4. D. Tanikić, Veštačke neuronske mreže, fazi logika i genetski algoritmi, Univerzitet u Beogradu, Tehnički fakultet u Boru, Bor, 2016.
5. Z. Miljković, Sistemi veštačkih neuronskih mreža u proizvodnim tehnologijama, Mašinski fakultet Beograd, 2004.
6. P. Subašić, Fazi logika i neuronske mreže, Tehnička knjiga, Beograd, 1997.

Number of classes per week	Lectures: 6	Practical classes: 4

Teaching methods: Lectures, practicals, practical tasks.

Knowledge evaluation (maximum 100 points)

Attendance 10 points, Activity during practicals 10 points, Practical tasks 30 points, Oral exam 50 points.

Course: Doctoral dissertation – defining the topic of the doctoral dissertation		
Lecturer/s: All study program teachers who can be mentors		
Status of the course: Obligatory for the Technological Engineering study program		
ECTS: 10		
Prerequisite: Passed all the exams from the curriculum of doctoral studies.		
Course goals: Application of basic, theoretical-methodological, scientific-professional and professional-applied knowledge, methods and the latest knowledge from journals from the SCI list in solving specific problems within the framework of doctoral studies..		
Learning outcomes: Enabling students to independently analyze and synthesize material from the subject of doctoral studies, apply previously acquired knowledge in structuring a research problem and defining possible directions for its solution. Independent use of literature sources from available databases in order to comprehensively see the defined research problem.		
Course description: It is formed individually for each student in accordance with the needs of further work in a specific case. The student studies professional literature to define possible solutions to the given problem through elaboration: a) research methodology that will be applied in the preparation of the doctoral dissertation, b) clearly defining the basic scientific contributions that are expected during the preparation of the doctoral dissertation. As a result of this work, the preparation of an essay with an explanation of the topic for the preparation of a doctoral dissertation, which is defended by a three-member Commission appointed by the Teaching and Research Council at the proposal of the department.		
Literature: Use of literature from available databases (SCOPUS, SCIENCEDIRECT, WEB of SCIENCE, PROQUEST, COMPENDEX, etc.).		
Number of classes per week	Lectures: 0	Practical classes: 10
Teaching methods: The mentor assigns the task of preparing an elaboration of the explanation of the scientific basis of the topic for the preparation of the doctoral dissertation. The initial literature is defined by the mentor, after which the candidate conducts independent research using available databases and other available literature. During the preparation of this essay, the mentor can give additional instructions and direct the candidate during the preparation of the essay explaining the topic for the preparation of the doctoral dissertation. During the elaboration of the thesis, the candidate performs the necessary measurements, analyzes and other researches in order to better define the research problem. After the defense of the essay, the mentor initiates the procedure for official approval of the topic for the preparation of the doctoral dissertation.		
Knowledge evaluation (maximum 100 points)		

Course: Doctoral dissertation – scientific research work 1		
Lecturer/s: All study program teachers who can be mentors		
Status of the course: Obligatory for the Technological Engineering study program		
ECTS: 30		
Prerequisite: Passed all the exams from the curriculum of doctoral studies.		
Course goals: Application of basic, theoretical-methodological, scientific-professional and professional-applied knowledge, methods and the latest knowledge from journals from the SCI list to solve specific problems within the subject of the doctoral dissertation. Within the defined topic for the preparation of the doctoral dissertation, the student studies the problem, its structure and complexity, performs analysis and synthesis and defines possible ways to solve it. The goal of the student's activities in this part of the studies is to gain the necessary experience for independently structuring the problem and finding ways to solve it.		
Learning outcomes: Enabling students to independently apply previously acquired knowledge from various fields and to focus the same on solving a specific problem. Through the independent use of literature, students expand their knowledge in a certain area and acquire knowledge in the use of modern tools and techniques for solving practical problems.		
Course description: It is formed individually in accordance with the needs of the doctoral dissertation. The student studies the professional literature and conducts the necessary research related to the topic of the doctoral dissertation (laboratory research, field work, etc.).		
Literature: Use of literature from available databases (SCOPUS, SCIENCEDIRECT, WEB of SCIENCE, PROQUEST, COMPENDEX, etc.).		
Number of classes per week	Lectures: 0	Practical classes: 20
Teaching methods: The mentor prepares the task for the candidate by defining the basic lines of research that emerged from the essay previously defended by the student in the preliminary procedure for defining the topic of the doctoral dissertation. During the preparation of the doctoral dissertation, the mentor can give additional instructions to guide the candidate towards a successful solution to the problem and the preparation of a quality doctoral dissertation.		
Knowledge evaluation (maximum 100 points)		

Course: Doctoral dissertation – scientific research work 2		
Lecturer/s: All study program teachers who can be mentors		
Status of the course: Obligatory for the Technological Engineering study program		
ECTS: 30		
Prerequisite: Passed all the exams from the curriculum of doctoral studies.		
Course goals: Application of basic, theoretical-methodological, scientific-professional and professional-applied knowledge, methods and the latest knowledge from journals from the SCI list to solve specific problems within the subject of the doctoral dissertation. Within the defined topic for the preparation of the doctoral dissertation, the student studies the problem, its structure and complexity, performs analysis and synthesis and defines possible ways to solve it. The goal of the student's activities in this part of the studies is to gain the necessary experience for independently structuring the problem and finding ways to solve it.		
Learning outcomes: Enabling students to independently apply previously acquired knowledge from various fields and to focus the same on solving a specific problem. Through the independent use of literature, students expand their knowledge in a certain area and acquire knowledge in the use of modern tools and techniques for solving practical problems.		
Course description: It is formed individually in accordance with the needs of the doctoral dissertation. The student studies the professional literature and conducts the necessary research related to the topic of the doctoral dissertation (laboratory research, field work, etc.).		
Literature: Use of literature from available databases (SCOPUS, SCIENCEDIRECT, WEB of SCIENCE, PROQUEST, COMPENDEX, etc.).		
Number of classes per week	Lectures: 0	Practical classes: 20
Teaching methods: The mentor prepares the task for the candidate by defining the basic lines of research that emerged from the essay previously defended by the student in the preliminary procedure for defining the topic of the doctoral dissertation. During the preparation of the doctoral dissertation, the mentor can give additional instructions to guide the candidate towards a successful solution to the problem and the preparation of a quality doctoral dissertation.		
Knowledge evaluation (maximum 100 points)		

Course: Doctoral dissertation – scientific research work 3		
Lecturer/s: All study program teachers who can be mentors		
Status of the course: Obligatory for the Technological Engineering study program		
ECTS: 5		
Prerequisite: Passed all the exams from the curriculum of doctoral studies.		
Course goals: Application of basic, theoretical-methodological, scientific-professional and professional-applied knowledge, methods and the latest knowledge from journals from the SCI list to solve specific problems within the subject of the doctoral dissertation. Within the defined topic for the preparation of the doctoral dissertation, the student studies the problem, its structure and complexity, performs analysis and synthesis and defines possible ways to solve it. The goal of the student's activities in this part of the studies is to gain the necessary experience for independently structuring the problem and finding ways to solve it.		
Learning outcomes: Enabling students to independently apply previously acquired knowledge from various fields and to focus the same on solving a specific problem. Through the independent use of literature, students expand their knowledge in a certain area and acquire knowledge in the use of modern tools and techniques for solving practical problems.		
Course description: It is formed individually in accordance with the needs of the doctoral dissertation. The student studies the professional literature and conducts the necessary research related to the topic of the doctoral dissertation (laboratory research, field work, etc.).		
Literature: Use of literature from available databases (SCOPUS, SCIENCEDIRECT, WEB of SCIENCE, PROQUEST, COMPENDEX, etc.).		
Number of classes per week	Lectures: 0	Practical classes: 20
Teaching methods: The mentor prepares the task for the candidate by defining the basic lines of research that emerged from the essay previously defended by the student in the preliminary procedure for defining the topic of the doctoral dissertation. During the preparation of the doctoral dissertation, the mentor can give additional instructions to guide the candidate towards a successful solution to the problem and the preparation of a quality doctoral dissertation.		
Knowledge evaluation (maximum 100 points)		

Course: Doctoral dissertation - preparation and defense of a doctoral dissertation		
Lecturer/s: All study program teachers who can be mentors		
Status of the course: Obligatory for the Technological Engineering study program		
ECTS: 25		
Prerequisite: Passed all the exams provided by the plan and program.		
Course goals: Doctoral dissertation defense.		
Learning outcomes: After successfully and independently completing and writing a doctoral dissertation in the field chosen when enrolling in doctoral studies, the candidate acquires the right to proceed with the defense of the doctoral dissertation.		
Course description: The student chooses a topic for his doctoral dissertation from the areas covered by the elective courses. The doctoral dissertation should contain the usual chapters: Title, Introduction, Literature Review, Working Hypothesis and Research Objective, Materials and Methods, Results, Discussion, Conclusion and References.		
Literature: Use of literature from available databases (SCOPUS, SCIENCEDIRECT, WEB of SCIENCE, PROQUEST, COMPENDEX, etc.).		
Number of classes per week	Lectures:	Practicals:
Teaching methods: Analysis of experimental data obtained by the methods used and processing of the results, as well as writing a dissertation, in consultation with the mentor and members of the Commission.		
Knowledge evaluation (maximum 100 points)		