Course Description	
Course title:	**Strength of materials**
Neptun code:	GEMET268M
Status: core, specialization, optional, other:	core
Type : lecture/seminar (practical)	2l. 1p.
Number of credits; hours per week	6; 3
Name and position of lecturer:	Dr. Dávid GÖNCZI lecturer
Contact of lecturer:	mechgoda@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 1
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	The main objective of this course is to provide the students with an introduction to the theory of elasticity, finite element modelling and plasticity. Further aim is to present the fundamental concepts and methodologies, then to apply them to the solutions of engineering problems (such as design of pressure vessels, pipes and tubes, disks or beams). Main topics: tensor algebra in indicial notation, kinematics of deformation for large and infinitesimal deformations, strain and stress tensors and measurement methods, constitutive equations, basic boundary value problem of thermoelasticity and its solution approaches, variational approach, basics of finite element modelling and plasticity.
Required readings:	1. Sadd M. H.: Elasticity: Theory, Applications and Numerics. Third edition, Academic Press, 2014. 2. Reddy J. N.: Energy Principles and Variational Methods in Applied Mechanics, 2nd Edition,
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Differential equations**
Neptun code:	GEMAN015M
Status: core, specialization, optional, other:	core
Type : lecture/seminar (practical)	2p.
Number of credits; hours per week	4; 2
Name and position of lecturer:	Dr. Péter VARGA associate professor
Contact of lecturer:	matvarga@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 2
Requirements (exam/practical mark/signature/report, essay)	practical mark

Course objectives (50-100 words):	The theory of differential equations is a basic tool of diverse fields of science. Students of this course should be able to understand their behaviors and to derive solutions of differential equations. The analysis of differential equations includes numerical, geometrical and analytical methods. The course covers linear and nonlinear, and also ordinary and partial differential equations. Nonlinear equations are studied by their linearization around the equilibrium solution. A short introduction to complex functions is presented. Laplace and Fourier methods are applied both to ordinary and partial equations Object and purpose of the course: Application of differential equations for characterization of static and dynamic systems. Linear systems theory, partial differential equations theory. Numerical methods. Thematic description of the subject: Concept and classification of ordinary and partial differential equations, geometric interpretation of first order differential equations. Numerical methods (Euler, Heun), Taylor's solution of the solution, error estimation. Qualitative behavior of first-order DE, concept of linearization. The problem of the existence and clarity of the solution. Homogeneous systems of linear differential equations. Eigenvalues and eigenvectors. Exponential function of matrices. Jordan resolution. Stability test. Complex exponential function. Derivation of complex functions, Taylor series. Nonlinear DE systems. Linearization, stability. Inhomogeneous constant coefficients DE (system). Pulse and frequency response. Laplace transformation and its applications. Line integrals of complex functions. Cauchy formulas. Types of partial DEs. Fourier series, integrals. Thermal equation and wave equation. Laplace operator and equation.
Required readings:	1. Paul Dawkins: Differential Equations (free textbook, http://tutorial.math.lamar.edu/Classes/DE/DE.aspx) 2. MIT OCW: Honors Differential Equation 18.034 http://mit.ocw.edu/courses/mathematics
Recommended readings:	P. Olver : Introduction to Partial Differential Equations, Springer, 2014.
Assessment methods and criteria:	

Course Description	
Course title:	**Applied Chemistry and Transport Processes**
Neptun code:	MAKKEM272M
Status: core, specialization, optional, other:	core
Type : lecture/seminar (practical)	2l, 1p
Number of credits; hours per week	4; 3
Name and position of lecturer:	Dr. Ferenc MOGYORÓDY associate professor
Contact of lecturer:	fkmmf@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 2
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	The purpose of the course: To introduce the students to the chemical knowledge required for non-chemical engineering activites. The course' content: Type and influence of the chemical reactions, the chemical speciality of the materials used in engineering. Quantity of the technological waters, chemical principles of technological water treatment. Water, water treatment, drinking water, industrial water, waste water and treatment. Type of catalysts and structures. Connection to chemical technologies. Raw materials of the chemical industry. Basics of Unit Operations. The chemistry of the natural gas, oil, mineral coal used for energy production. Energy production. Basics of the Green chemistry. Basics of C1-chemistry, Transport processes, viscosity, diffusion, heat transport, electric conductance, basics of hydrodynamics. Corrosion phenomena.

Required readings:	1. The material of the lectures is available for the students in pdf format. 2. P.W.Atkins: Physical Cemistry II. 3. Plawsky, Joel L. (April 2001). Transport phenomena fundamentals (Chemical Industries Series). CRC Press. pp. 1, 2, 3. ISBN 978-0-8247-0500-8. 4. Transport Phenomena (1 ed.). Nirali Prakashan. 2006. p. 15-3. ISBN 81-85790-86-8., Chapter 15, p. 15-3
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Materials equilibria**
Neptun code:	MAKFKT345M
Status: core, specialization, optional, other:	core
Type : lecture/seminar (practical)	2l.
Number of credits; hours per week	4; 2
Name and position of lecturer:	Dr. György KAPTAY professor
Contact of lecturer:	kaptay@hotmail.com
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 2
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	Aim of the course: To demonstrate that in addition to classical temperature, pressure, and composition state determinants, phase size is determinative in the nanometer range, that is, it determines phase equilibria, not to mention chemical and electrochemical equilibria. Students will learn the expected phase balance, chemical balance in nano-sized materials and the basics of electrochemical equilibrium. To teach both theoretically and technically how to calculate phase equilibria in one- and two-component materials systems and how to read the characteristics of equilibrium from them. Keywords: System, phase, component, mole fraction, phase fraction, materials balance, characteristics of the equilibrium state, state parameters, Gibbs energy, laws of thermodynamics, condition of global and heterogeneous equilibria, phase rule, one-component phase diagrams (construction and interpretation), Gibbs energy of two-component mixtures and solutions, ideal solution and their phase diagrams (their derivation and interpretation), solutions models and the 4th law, compound phases, two-component phase diagrams (their derivation, interpretation and classification), phase diagrams + phase ratio diagrams + phase composition diagrams.
Required readings:	1. N.Saunders, AP Miodownik: CALPHAD, a Comprehensive Guide, Pergamon, 1998, 479 p 2. Lukas HL, Fries SG, Sundman B: Computational Thermodynamics. The Calphad method. Cambridge University Press, 2007, Cambridge, UK, 313 pp. 3. G.Kaptay: On the tendency of solutions to tend toward ideal solutions at high temperatures – Metall Mater Trans A, 2012, vol.43, pp. 531-543. 4. G.Kaptay: Nano-Calphad: extension of the Calphad method to systems with nano-phases and complexions - J Mater Sci, 2012, vol.47, pp.8320-833 5. G.Kaptay. The exponential excess Gibbs energy model revisited. Calphad, 2017, vol.56, pp.169-184. doi: 10.1016/j.calphad.2017.01.002. + course material (manuscript) written by G.Kaptay 2016 – 2018.
Recommended readings:	
Assessment methods and criteria:	Requirements during the semester: Personal home works for maximum 100 points (calculation of phase diagrams using EXCEL). Extra points can be gained during classes. On exam: oral presentation on two questions for maximum 100 points. Total maximum 200+ points. Teaching method: oral, using a blackboard (no computer during classes). Evaluation: At the end of semester: below 10 points: not allowed to exam; above 50 points: allowed to exam. Final mark: 100 – 119 points: satisfactory; 120 – 139 points: medium; 140 – 159 points: good; 160 and above: excellent.

Course Description

Course title:	**Interfacial phenomena**
Neptun code:	MAKFKT347M
Status: core, specialization, optional, other:	core
Type : lecture/seminar (practical)	2l.
Number of credits; hours per week	4; 2
Name and position of lecturer:	Dr. György KAPTAY professor
Contact of lecturer:	kaptay@hotmail.com
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 1
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	Study goals: Demonstrate that material engineering practice can only be extended to nano-material production if the engineer acquires knowledge of interfacial phenomena. To make it clear that the majority of materials technologies are dependent on interfacial phenomena. Teaching the method to convert this understanding into the ability for materials and technological design Course' content: Basics on interfaces (specific surface area, molar surface area, classification and understanding of interfacial energies, the integral Gibbs energy as function of interfacial energies). Modeling interfacial energies (surface tension, surface energy, liquid/liquid interfacial energy, solid/liquid interfacial energy, solid/solid interfacial energy) as function of materials quality (chemical bond type) and temperature. Modeling interfacial energies as function of composition (Gibbs and Langmuir vs. Butler). Understanding and modeling interfacial phase separation. Phase equilibria influenced by interfacial energies (the extended phase rule and the corrected phase diagrams). Understanding interfacial forces. Modeling complex phenomena involving interfacial forces.
Required readings:	1. A.W.Adamson: Physical Chemistry of Surfaces, 5th ed., John Wiley and Sons Inc., NY, 1990. 2. J.N.Israelachvili: Intermolacular and surface forces, Academic Press, London, 1992 3. R.Defay, I.Prigogine, A.Bellemans, D.H.Everett. Surface tension and adsorption. Logmans, Green and Co, London (1966). 4. H.N. Butt, K. Graf, M. Kappl. Physics and Chemistry of Interfaces. Weinheim: Wiley (2003). 5. N.Eustathopoulos, M.G.Nicholas, B.Drevet: Wettability at High Temperatures, Pergamon, 1999, 420 pp. + course material (manuscript) written by G.Kaptay 2015 – 2018.
Recommended readings:	
Assessment methods and criteria:	Requirements during the semester: One home work + one test for maximum 100 points. Extra points can be gained during classes. On exam: oral presentation on two questions for maximum 100 points. Total maximum 200+ points. Teaching method: oral, using a blackboard (no computer during classes). Evaluation: At the end of semester: below 10 points: not allowed to exam; above 50 points: allowed to exam. Final mark: 100 – 119 points: satisfactory; 120 – 139 points: medium; 140 – 159 points: good; 160 and above: excellent.

Course Description	
Course title:	**Intellectual properties law**
Neptun code:	MAKPOL264M
Status: core, specialization, optional, other:	core
Type : lecture/seminar (practical)	3p.
Number of credits; hours per week	4; 3
Name and position of lecturer:	Dr. György CZÉL professor
Contact of lecturer:	femczel@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 4
Requirements (exam/practical mark/signature/report, essay)	practical mark

Course objectives (50-100 words):	Study goals: The purpose of subject is to acquaint the students with the forms of intellectual property law. Course content: The means of effective protection of intellectual property is demonstrated in the framework of this subject. The following topics are especially highlighted: 1. The branches of protection of intellectual property and their fields 2. The concept, subject and extent of copyright 3. The concept and significance of voluntary register of works and the process of procedure Copyrights and their limits 4. The professional book as a task of copyright; the cases of free adaptation 5. The professional paper as a paper of copyright, citation and reference 6. Linked and adjacent legitimacy and their limits in the copyright 7. Specification of safe-keeping forms known in the industrial legal protection and the short review of their different fields. 8. The content and limits of licences and patents as the safe-keeping form of industrial legal protection 9. The structure of description of patent. The conditions of patentability 10. Possibilities of obtaining the EU patents 11. The development and significance of patent data base 12. Content and development of the utility model protection 13. Significance and sphere of protection of trade marks. Content of classification system developed in Viena and Nice. The Community Trade Mark 14. Extent and significance of design protection 15. Significance of geographical indication. Method of validation and content of this form of protection
Required readings:	1. WIPO: Protection of Intellectual properties 2. L. Bently, B. Sherman: Intellectual Property Law 3. R. Radhakrishnan,S. Balasubramanian: Intellectual Property Rights 4. Howell Claire, Farrand Benjamin: Intellectual Property Law
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Project management**
Neptun code:	MAKMET30M
Status: core, specialization, optional, other:	core
Type : lecture/seminar (practical)	4p
Number of credits; hours per week	4; 4
Name and position of lecturer:	Dr. Béla TÖRÖK associate professor
Contact of lecturer:	bela.torok@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 4
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	The course aims at helping students to be familiar with project management concepts, terms, roles and processes. They will learn: How projects are defined. How the structure of an organization impacts project management. How project management roles and responsibilities are defined. How all projects can be mapped to the same basic life cycle structure. How project management can be organized into functional areas. Course content: Project management has evolved to plan, coordinate and control the complex and diverse activities of modern industrial, commercial and management change and IT projects. The purpose of project management is to foresee or predict as many of the dangers and problems as possible and to plan, organize and control activities so that projects are completed successfully in spite of all the risks. The course involves the descriptions about perspectives, principles, stakeholders, sponsors, managers and processes of a general project. Moreover the course provides detailed information about managing the team, scope, schedule, budget, quality and risks of the projects.

Required readings:	1. Dennis Lock: Project Management. Gower Publishing Limited (UK), 2013. ISBN-13: 978-0-566-08772-1 2. Rodney Turner: Handbook of Project Management. Gower Publishing Limited (UK), 2012 3. Scott Berkun: Art of Project Management. Cambridge, MA: O'Reilly Media. ISBN 0-596-00786-8 (2005) 4. A Guide To The Project Management Body Of Knowledge, 3rd ed., Project Management Institute. ISBN 1-930699-45-X (2003) 5. James Lewis: Fundamentals of Project Management, 2nd ed., American Management Association. ISBN 0-8144-7132-3 (2002)
Recommended readings:	Berkun, Scott. Art of Project Management. Cambridge, MA: O'Reilly Media. ISBN 0-596-00786-8 (2005) Brooks, Fred. The Mythical Man-Month, 20th Anniversary Edition, Adison Wesley. ISBN 0-201-83595-9 (1995) Heerkens, Gary. Project Management (The Briefcase Book Series). McGraw-Hill. ISBN 0-07-137952-5 (2001) Kerzner, Harold. Project Management: A Systems Approach to Planning, Scheduling, and Controlling, 8th Ed., Wiley. ISBN 0-471-22577-0 (2003) Lewis, James. Fundamentals of Project Management, 2nd ed., American Management Association. ISBN 0-8144-7132-3 (2002) Meredith, Jack R. and Mantel, Samuel J.. Project Management : A Managerial Approach, 5th ed., Wiley. ISBN 0-471-07323-7 (2002) Project Management Institute. A Guide To The Project Management Body Of Knowledge, 3rd ed., Project Management Institute. ISBN 1-930699-45-X (2003)
Assessment methods and criteria:	Signature: test writing (20 questions, at least 11 good answers = allowed to exam) Exam: written work based on 3 essay tasks

Course Description	
Course title:	**Quality management systems**
Neptun code:	MAKMKT520EN
Status: core, specialization, optional, other:	core
Type : lecture/seminar (practical)	3l.
Number of credits; hours per week	4; 3
Name and position of lecturer:	Prof. Csaba Deák, professor
Contact of lecturer:	deak.csaba@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 4
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	The objective of the course is to learn quality management concept of production companies; the main quality-related tasks at management level. The students will be able to organise their works and work processes in a quality-oriented manner. The topics are supported by best practice case studies. The students solve practice-oriented project tasks. Course content: Essentials and tendencies of quality approaches. The main areas of quality management (QM). Special QM tasks in material science research institutes and laboratories. Process model of quality management. Introduction to the ISO 9001 quality management standard; QM audit process. Essentials of Total Quality Management (TQM). Statistical Process Control (SPC); its place in QM and the connecting managerial tasks. Lean Six Sigma as a QM/QA system. Managerial support of continuous improvement (CI). Supplier Quality Management (SQM), tendencies and standards. Challenges of Quality 4.0.
Required readings:	• Juran, J. M.: A history of managing for quality: The evolution, trends, and future directions of managing for quality, ASQC QP, 1995. • Juqulum, R.: Design for lean six sigma: A holistic approach to design and innovation, Wiley, 2008. • Chandupatla, T.R.: Quality and reliability in engineering, Cambridge, 2009. • Luis, R-L: Building quality management systems: Selecting the right methods and tools, CRC, 2013.
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Microstructure investigations II.**
Neptun code:	MAKFKT346M
Status: core, specialization, optional, other:	core
Type : lecture/seminar (practical)	1l. 2p.
Number of credits; hours per week	6; 3
Name and position of lecturer:	Dr. Gréta GERGELY associate professor
Contact of lecturer:	femgreta@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 1
Requirements (exam/practical mark/signature/report, essay)	practical mark
Course objectives (50-100 words):	Students acquire knowledge about special microstructure investigation techniques. Some of them will be used in practice and theory as well. Course content: Morphological classification of single and multi-phase materials. Characterization of grains and particles, interpretation of grain size distribution. Structural anisotropy and orderliness. Classification of two dimensioned grains by shape. Principles of SEM, XRD and TEM. Using image analysis method to characterize multi-phase structural. Project work. In the framework of project work, all students get an unknown sample. During lecture to pratical course, students get information about his/her samples. The source of the information is provided by the studied examination methods. Based on this approach, they get knowlegde both the theoretical and practical side of the techniques, while the identify and characterize their samples. At the end of the semester, students have to make a presentation about their samples, i.e. they have to present their project.
Required readings:	1. Microstructural Investigation and analysis, Volume 4, B. Jouffrey, Online ISBN: 9783527606160, Print ISBN: 9783527301218, DOI: 10.1002/3527606165 2. ASM Metals Handbook, Ninth Edition, v. 9, ""Metallography and Microstructures"", American Society for Metals, Metals Park, OH, 1985, p. 1 3. Underwood E. E.: Quantitative Stereology. Menlo Park, California. Addison-Wesley Publishing Company. (1970) p. 23.
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Composites**
Neptun code:	MAKFKT305M
Status: core, specialization, optional, other:	core
Type : lecture/seminar (practical)	2l. 1p.
Number of credits; hours per week	6; 3
Name and position of lecturer:	Dr. Gréta GERGELY associate professor
Contact of lecturer:	femgreta@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 3
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	“Composites” is a one-semester course which is designed to provide students the general knowledge about composite materials. Lectures give the theoretical background, while practical work realize the knowledge utilization. The course covers the following topics: type and classification of composites (general); role of composites (general); classification of composites (general); classification of reinforcements, fabrication and properties of different type of reinforcements; main types of matrix materials and their properties; types and fabrication processes of PMC and CMC composites; types and production methods of MMCs; application field of different types of composites. Preparation and investigation of own MMC composite sample. Calculation practice. Project work Students can choose a self defined composite topic. In this field they have to collect 3-5 scientific article. They have to process the articles. It means they have to prepare literature matrix (highlight the aim of the studies, the applied techniques and the main results/ conclusions). Finally students have to present the main results of the articles and the compariosn of the different studies in a framework of a presentation.

Required readings:	1. KrishanK.Chawla. CompositeMaterials. Science andEngineering. ISBN 978-0-387-74364-6 ISBN 978-0-387-74365-3 (eBook) DOI 10.1007/978-0-387-74365-3 Springer New York Heidelberg Dordrecht London 2013 2. ASM Handbook Volume 21: Composite. Editor: D.B. Miracle and S.L. Donaldson. ISBN: 978-0-87170-703-1 3. Deborah D.L.Chung. CompositeMaterials. Science and Applications ISSN 1619-0181 ISBN 978-1-84882-830-8 e-ISBN 978-1-84882-831-5 DOI 10.1007/978-1-84882-831-5 Springer London Dordrecht HeidelbergNewYork
Recommended readings:	
Assessment methods and criteria:	

SPECIALIZATIONS

POLYMER ENGINEERING

Course Description	
Course title:	**Polymer adhesives**
Neptun code:	MAKPOL260-17-M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l. 2p.
Number of credits; hours per week	8; 4
Name and position of lecturer:	Dr. Tamás J. SZABÓ associate professor
Contact of lecturer:	tamas.szabo.mak@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 1
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	The course explains in detail the most common, every day glues and adhesives, their theory and practical application. Course content: Explaining of the chemistry and physics of the bond formation, and mechanisms. Discussing the importance of interfacial processes, their measurement and modification. Examination, determination and modification of flow properties of different liquid adhesives. Detailed discussion is presented about the processes occurring during joining and the methods of testing of the adhesives and the joints. Introduction of most common and historical important natural and synthetic adhesives, their properties and application. Using common glues the general definitions and their usage is explained. Trough examples we can evaluate the potential errors, their causes and practical ways to avoid them. For different material groups we discuss the optimal joining method for the plant loadbearing structures.
Required readings:	1. Anthony J. Kinloch: Adhesion and Adhesives: Science and Technology 2. Sina Ebnesajjad, Arthur H. Landrock: Adhesives Technology Handbook 3. David Lammas: Adhesives and Sealants (Workshop Practice)
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Operation of polymer processing machines**
Neptun code:	MAKPOL262M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l. 2p.
Number of credits; hours per week	8; 4
Name and position of lecturer:	Dr. György CZÉL professor
Contact of lecturer:	femczel@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 3

Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	Processing of plastic materials and technology of shaping of plastic products as well as the operation of machines. The different moulding technologies will be presented in detailed mechanical drawings and tool drawings. The students can learn the details of technology of production of thermoplastic materials by extrusion and injection moulding. The basic principles of the detailed calculation of extruder as well as of the sizing of screw will be the topics of lectures. The following tools will be detailed as moulding tools: Extruder- and injection -moulds for making thermoplastic materials. Pressing dies for making thermoset products. Thermal transport process during the formation of different plastic materials. Energy consumption necessary for producing different plastic products i.e. for maintaining the different technological lines. The problems of productivity. Aspects of choosing the technical plastic materials and the technologies that can be allocated to them. Educated processes: mixing, hot mixing, rolling, calendaring, injection moulding, extrusion, blow moulding, Hot-forming of plastics, vacuum forming, fiberising techniques, their material-specific characteristics and machinery. Calculation tasks: Calculation of closing force during injection moulding. Extent of orientation during extruded tube blowing.
Required readings:	1. Sors-Balázs: Design of Plastic Moulds and dies Akadémiai Kiadó 1989 ISBN 963 05 4690 6 2. Robert O. Ebewelle: Polymer Science and Technology, CRC Press Boca Raton, New York, 2000.
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Polymer study II.**
Neptun code:	MAKPOL261M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	3l. 1p.
Number of credits; hours per week	8; 4
Name and position of lecturer:	Dr. Kálmán MAROSSY professor
Contact of lecturer:	marossyk@gmail.com
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 2
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	The aim of the course is to deepen students' knowledge of polymeric materials, formerly Polimertan I scientific explanation of the relationships learned in the course, acquisition of new knowledge. Course' content: Polymers and plastics definition. Preparation of polymer molecules. Description of polymers; average molecular weight, polydispersity. Stereo isomers, tacticity. Chain flexibility of polymers, related properties. Structure of polymeric bulks, behavior of polymeric chains and molecules, behavior of polymer segments in different force fields. Quantitative evaluation of physical behavior, using different methods. Determination of connections between the different behaviors (optical, electric, mechanical, thermal, etc…). Compatibility of polymers and additives, thermodynamics of mixing, preparation of blends and mixed systems. Structure-properties relations.
Required readings:	1. Painter, Paul C.; Coleman, Michael M. (1997). Fundamentals of polymer science : an introductory text. Lancaster, Pa.: Technomic Pub. Co. p. 1. ISBN 1-56676-559-5 2. McCrum, N. G.; Buckley, C. P.; Bucknall, C. B. (1997). Principles of polymer engineering. Oxford ; New York: Oxford University Press. p. 1. ISBN 0-19-856526-7. 3. Ashby, Michael; Jones, David (1996). Engineering Materials (2 ed.). Butterworth-Heinermann. pp. 191–195. ISBN 0-7506-2766-2.
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Polymer product design**
Neptun code:	MAKPOL263M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	1l. 3p.
Number of credits; hours per week	8; 4
Name and position of lecturer:	Dr. Tamás J. SZABÓ associate professor
Contact of lecturer:	tamas.szabo.mak@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 4
Requirements (exam/practical mark/signature/report, essay)	practical mark
Course objectives (50-100 words):	Learn to conceptualize and evaluate ideas before turning them into products. Description of the conceptual process for the preparation of a given object, with particular regard to material selection. During the semester, students may encounter various manufacturing and processing problems and criteria that can better understand the problems of introducing a new product. Choose a polymer product (keyholder, firsbee etc.). Design the look of the product, the processing method and choose the best polymer base material. The students have to build up their project based on their selection of product as checking the historical and current materials choices. They have to define a property criteria parameter set in order for the product fulfill its intended purpose. They have freedom of design the lock of the product but they have to pick a material and a processing technique which can produce their envisioned design. They have to prepare a written material describing the design, selection, process with some conceptual drawings of their product by the end of the semester. At the end of the semester they have to give a short presentation about their product, the material, the design, the process and their path getting there.
Required readings:	1. Process: 50 Product Designs from Concept to Manufacture by Jennifer Hudson Publisher: Laurence King Publishing; 2 edition (May 11, 2011) ISBN-10: 1856697258 ISBN-13: 978-18566972552008. 2. M.F. Ashby: Material selection in Mechanical Design: Materials Selection in Mechanical Design Szerző Michael F. Ashby Publisher: Butterworth- Heinemann, 2004. ISBN 0080468640, 9780080468648
Recommended readings:	
Assessment methods and criteria:	

CHEMICAL TECHNOLOGY

Course Description	
Course title:	**Colloid chemistry**
Neptun code:	MAKKEM273-17-M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l; 2p
Number of credits; hours per week	7; 4
Name and position of lecturer:	Dr. Milán SZŐRI associate professor
Contact of lecturer:	milan.szori@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 1
Requirements (exam/practical mark/signature/report, essay)	exam

Course objectives (50-100 words):	1. Introduction to Colloid and Surface Chemistry: the importance of the surface for small particles, classification of colloids based on affinity to carrier fluid, concept of stability of colloidal systems some physical characteristics of colloids. 2. Sedimentation and diffusion and their equilibrium: gravitational and centrifugal sedimentation, Brownian motion and diffusion. Basic of the random coil and random walk statistics. 3. Solution Thermodynamics: Osmotic and Donnan equilibria. Osmotic equilibrium in charged systems 4. The rheology of dispersions: Newton's Law of viscosity. Viscometers. The equation of motion: Navier-Stokes equation. Einstein's theory of viscosity of dispersions. Beyond the Einstein Model, Non-Newtonian behavior. Viscosity of polymer solutions 5. Static and dynamic light scattering and other radiation scattering 6. Surface tension and contact angle. Effects of curved interfaces on phase equilibria and nucleation: the Kelvin equation. Contact of liquids with porous solids and powders. Molecular interpretation of surface tension. 7. Adsorption from solution and monolayer formation. The Gibbs equation. Adsorption on solid surfaces. Applications of adsorption from solution 8. Association Colloids. Colloidal structures in surfactant solutions. Structure and Shapes of Micelles. Critical micelle concentration (cmc) and the thermodynamics of micellization. Solubilization. Reverse micelles. Emulsions and microemulsions. Biological membranes. 9. Adsorption at gas-solid interfaces: experimental and theoretical treatments of adsorption. Thermodynamics of adsorption. Multilayer adsorption: The Brunauer-Emmett-Teller (BET) isotherm. Adsorption in porous solids and on crystallines. 10. van der Waals Forces. Role of van der Waals forces in Colloid and Surface Chemistry. Molecular Origins and the Macroscopic Implications of van der Waals Forces. Extremes: van der Waals Forces Between Large Particles and Over Large Distances 11. The Electrical Double Layer and Double-Layer Interactions. Surface Charges and Electrical Double Layer: The Capacitor Model, The Debye-Huckel Approximation, Gouy-Chapman Theory. Stern Adsorption. 12. Electrophoresis and other electrokinetic phenomena. Mobilities of small ions and macroions in electric fields. Zeta potential. Electroosmosis. Streaming potential. The surface of shear and viscoelectric effect. Applications of electrokinetic phenomena. 13. Electrostatic and Polymer-Induced Colloid Stability. Interparticle forces and the structure and stability of dispersions. The Derjaguin-Landau-Verwey-Overbeek (DLVO) theory of colloid stability
Required readings:	1. Paul C. Hiemenz, Raj Rajagopalan: Principles of Colloid and Surface Chemistry (3rd Edition), CRC Press, New York (1997). ISBN 0-8247-9397-8 2. Barnes G.T., Gentle I. R.: Interfacial Science, Oxford University Press, (2005). ISBN 978-0199571185 3. Arthur W. Adamson, Alice P. Gast Physical Chemistry of Surfaces, John Wiley &Sons, Inc., New York (1997) ISBN 0-471-14873-3 4. Laurier L. Schramm: Emulsions, Foams, Suspensions, and Aerosols Microscience and Applications (2nd Edition) Wiley-VCH Verlag GmbH & Co. (2014). ISBN: 978-3-527-33706-42014 5. Carl W. Garland, Joseph W. Nibler, David P. Shoemaker: Experiments in Physical Chemistry (8th edition) McGraw-Hill, New York 2009, ISBN 978-0-07-282842-9
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Reaction kinetics and catalyzis**
Neptun code:	MAKKEM275-17-M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	3l; 1p
Number of credits; hours per week	7; 4
Name and position of lecturer:	Dr. Béla VISKOLCZ professor
Contact of lecturer:	bela.viskolcz@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 2
Requirements (exam/practical mark/signature/report, essay)	exam

Course objectives (50-100 words):	The (chemical) thermodynamics and reaction kinetics. Reaction parameters affecting chemical changes, reactions and speeds. Reaction rate, velocity equation, reaction order, molecularity. Experimental determination of reaction rate. Homogeneous chemical reactions. Speed equations of simple reactions. Reaction of the reaction. Determination of reaction order and subdivisions. Null, first, second, third, n-ed reactions. Dependence of reaction rate. Collision and Activated (Temporary) Complex Theory. Pressure volume-dependent reactions. Compound reactions. Parallel reactions. Serial reactions. Consecutive-competitive responses. Homogeneous catalytic reactions, autocatalytic reactions. Stage reactions, chain reactions, combustion, explosion, detonation. Reversible steady and irreversible reactions. Heterogeneous reactions. Parameters influencing heterogeneous processes. Heterogeneous catalysis, heterogeneous catalysts. Reactor types suitable for industrial application of reactions. Decomposition reactions. Thermal, catalytic, decomposition. Kinetics of polymerization processes. Types of chemical reactors. Introduction to the operation of chemical processes.
Required readings:	1. G. F. Froment, K. B. Bischoff: Chemical Reactor Analysis and Design. John Wiley & Sons, 1990. 2. M.J. Pilling- P.W. Seekins: Reaction Kinetics Oxford Science Publications, 1996. 3. O. Levenspiel: Chemical Reaction Engineering. John Wiley & Sons, 1999. 4. P. Atkins, J. de Paula, Physical Chemistry 9th Edition, Oxford University Press 2010.
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Chemical processes II.**
Neptun code:	GEVGT227-17-M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	3l; 3p
Number of credits; hours per week	7; 6
Name and position of lecturer:	Dr. Gábor L. SZEPESI associate professor
Contact of lecturer:	szepesi@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 3
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	Object and purpose of the course: The aim and task of the course is to provide students with a basic understanding of the operational calculus of heat transfer related tasks, and to be able to dimension appliances / equipment. This course will introduce the basics of the unit operations and chemical processes. The students will get to know the fundamentals of mechanical separation technics (including filtration, sedimentation, fluidization, gas-solid separation), the methods of the heat transfers and evaporation, basics and detailed knowledge of mass transfer (including the phase equilibrium between vapor-liquid, gas-liquid and solid-liquid phases). During the course the students pick up a knowledge about the operational calculation of the heat exchangers and distillation and absorption columns. This subject also introduces the drying methods and equipment. The topic is as follows: presentation of heat transfer forms. Fourier I. Experimental Heat Conductivity and the Differential Equation of Heat Conduction. The differential equation of heat conduction and convection. Numerical methods for calculating thermal conductivity. Convective forms of heat transfer. Criteria for similarity. Determination of heat transfer coefficients in and outside the pipe. Basic equation for heat exchangers, standard temperature difference. Heat exchanger structures. Thermal radiation. Operation of evaporation. Evaporative constructions. Barometric vacuum condenser.
Required readings:	1. Perry's Chemical Engineers' Handbook, Eighth Edition. McGraw-Hill Education – Europe. 2007. New York. ISBN 978-0-07-142294-9 Vol. 5,6,11,12,13,15,16,17,18 2. Ramesh K. Shah, Dus˘an P. Sekulic - Fundamentals of heat exchanger design. John Wiley & Sons, Inc., Hoboken, New Jersey pp97 - pp227. ISBN 0-471-32171-0 3. Diran B. - Mass Transfer -Principles and Applications 2004 CRC Press LLC ISBN 0-8493-2239-1 pp.1-33, pp189-238. pp243-345.
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Modelling of chemical systems**
Neptun code:	MAKKEM285EN
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l; 1p
Number of credits; hours per week	3; 3
Name and position of lecturer:	Dr. Péter MIZSEY professor
Contact of lecturer:	kemizsey@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 3
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	Object and purpose of the course: Learn the basics of chemical process modeling. Course' content: Analysis and synthesis of chemical processes. The application areas of modelling in the practice of chemical engineering. Set up of models for chemical unit operations, processes, technologies. Design equations. Elements of models, mass balance, heat balance, transport processes. Theories, alternatives and practice of modelling. Different levels of chemical prong, unit operation level, complex systems, processes and technologies. Specialties and challenges of the different levels. Treatment of heat and mass recycles. Convergence acceleration. Computer aided chemical engineering. Professional flowsheeting packages. Individual work: design and modelling of chemical processes.
Required readings:	1. William L. Luyben, Process Modeling, Simulation, and Control for Chemical Engineers, ISBN 0-07-017762-7 2. J. M. Douglas, Conceptual Design Chemical Processes, ISBN 0-07-017762-7
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Optimalization of chemical systems**
Neptun code:	MAKKEM280-17-M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l, 1p
Number of credits; hours per week	4; 3
Name and position of lecturer:	Dr. Péter MIZSEY professor
Contact of lecturer:	kemizsey@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 3
Requirements (exam/practical mark/signature/report, essay)	exa

Course objectives (50-100 words):	Object and purpose of the course: The course is designed to provide students with a deeper understanding of chemical industry modeling. The aim is that students be able to examine smaller systems using available software and learn the modeling capabilities of more complex heat and material transfer processes. Course' content: Modelling, different applicable models, basics of mathematical modelling aiming to determine an objectiive function for the sake of optimization. Definition of local and global optima. Examples for objective function model: unit operations, perfectly mixed tank reactor, plug flow reactor Optimization methods: Classical function analysis, maxima and minima, analysis of derivatives Theory and method of Lagrange multiplicator Non-linear programming, basics, numerical calculation of derivatives, different kinds of gradient methods, other numerical methods. Methods without gradients, determination of minima and maxima of objective function of one variable and multivariable. Scanning method. Comparison of methods, methods for global and local optimization. Individual optimization work.
Required readings:	1. Rajesh Kumar Arora, Optimization: Algorithms and Applications, ISBN-13: 978-1498721127 2. Suman Dutta, Optimization in Chemical Engineering, ISBN: 9781107091238
Recommended readings:	
Assessment methods and criteria:	

HEAT TREATMENT AND METAL FORMING

Course Description	
Course title:	**Physical metallurgy of heat treated metals and alloys**
Neptun code:	MAKFKT348M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	3l.
Number of credits; hours per week	6; 3
Name and position of lecturer:	Dr. Péter BARKÓCZY associate professor
Contact of lecturer:	peter.barkoczy@gmail.com
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 1
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	The attached areas during the course: basics of solid state phase transformation. Princilples of recrystallization and recovery, the annealing heat treatment. Kinetics of precipitiation from super saturated solid solution, the anging process. Basics of allotropic phase transformation of pure metals and solid soutions. Ausztenitization and normalizing of steels, and the basics of transformation diagrams. Principles of martensitic and bainitic transformations, quenching, aging and tempering. The course mainly deals with the phisical metallirgic description of the processes, but give some additional practical data and process related to aluminum, copper and steel heat treatments.
Required readings:	1. S. Banerjee and P. Mukhopadahyay: Phase transformations, Pergamon Press, 2. D. A. Porter and K. E. Easterling: Phase transformations in metals and alloys, CRC Press 3. J. Humphreys: Recrystallization and related phenomena, Elsevier
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Fundamentals of metal forming**
Neptun code:	MAKFKT350-17-M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	3l.
Number of credits; hours per week	6; 3

Name and position of lecturer:	Dr. György KRÁLLICS professor
Contact of lecturer:	femkgy@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 3
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	Mechanism of plastic deformation. Anisotropic behaviour of deformed body. Cold and hot deformation, recrystallization. Continuum mechanical aspects of plastic deformation. A summary of tensor calculus. Deformation and stress state in deformable body. Constitutive law of materials, and methodology on determination of their parameters. Workability of metals and mathematical description of damage evaluation. Tribology of metal forming processes and determination of its parameters. Computation methods for the calculation of force and deformation on basic forming processes. Using of engineering technical computing software for the planning of metal forming processes.
Required readings:	1. B, Avitzur, Metal Forming : Proceses and Analysis, Mc Graw-Hill Book Company, 1968. ISBN-10:007002510X ISBN-13:978-0070025103 2. R.H.Wagoner, J.-L. Chenot : Metal Forming Analysis. Cambridge, University Press, 2001, ISBN-10 0-521-64267-1 ISBN-13 978-0-521-64267-5 3. R.H.Wagoner, J.-L. Chenot : Fundamentals of metal forming. John Wiley & Sons, Inc. 1997, ISBN 10:0471570044 ISBN-13:9780471570042 4. Han-Chin Wu : Continuum Mechanics and Plasticity. Chapman & Hall/CRC Press,2005, ISBN-10 :1584883634, ISBN-13 9781584883630
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Simulation of heat treatment processes**
Neptun code:	MAKFKT349M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	1l. 3p.
Number of credits; hours per week	8; 4
Name and position of lecturer:	Dr. Péter BARKÓCZY associate professor
Contact of lecturer:	peter.barkoczy@gmail.com
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 2
Requirements (exam/practical mark/signature/report, essay)	practical mark
Course objectives (50-100 words):	Basics of the simulation and modelling. Concept of physical and numerical simulations. Difference between the property and microstructural simulation. Solution of the kinetic equation. Numerical computation methods. Simulation of phase transformation based on a regression model. Cellular automaton method, and its application in materials science. Level-Set method and the solution possibillities of the level set equation.
Required readings:	1. B. Chopard and M. Droz: Cellular automata simulation of Physical Systems, Cambridge University Press 2. J. L. Schiff: Cellular Automata, Wiley-Interscience 3. Czichos, Saito, Smith ed.: Handbook of Metrology and Testing, Springer
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Simulation of deformation technologies**
Neptun code:	MAKFKT351M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	1l. 3p.
Number of credits; hours per week	8; 4
Name and position of lecturer:	Dr. Sándor KOVÁCS associate professor

Contact of lecturer:	femkovac
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 4
Requirements (exam/practical mark/signature/report, essay)	practical mark
Course objectives (50-100 words):	The course's subject are specified in the followings: - presenting how to opearate a die-forging based FEM-software which is used for designing metal forming technologies; - comparing the results of the measuerements to the results of the simulations; - rolling, forging, drawing and extrusion forming problems' termo-mechanical approach; - solving specifed metal forming boundary condition problems with FEM softwares; - implementing an expirement of a metal forming problem then simulating it with a FEM software; - comparing the measured and the computed results of the problem.
Required readings:	1. H.S. Valberg: Applied metal forming including FEM analysis. Cambridge University Press. 2010. 2. MSc Marc Tutorials 3. Páczelt István, Szabó Tamás, Baksa Attila: A végeselem-módszer alapjai. Prof. Dr. Páczelt István, 2007
Recommended readings:	4. R.H. Wagoner, J.L.Chenot: Metal Forming Analysis. Cambridge University Press. 2001. 5. P.M. Dixit, U.S.Dixit : Modeling of Metal forming and Machining Processes, Springer, 2008 6. Pánczelt István- Herpai Béla: A végeselem-módszer alkalmazása rúdszerkezetekre. Műszaki Könyvkiadó, Budapest 1987
Assessment methods and criteria:	

Course Description	
Course title:	**Complex planning or Project work**
Neptun code:	MAKFKT325M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2p.
Number of credits; hours per week	4; 2
Name and position of lecturer:	Dr. Gréta GERGELY associate professor
Contact of lecturer:	femgreta@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 4
Requirements (exam/practical mark/signature/report, essay)	practical mark
Course objectives (50-100 words):	Aim of the course to prepare students to manage and write a successfully thesis. Course content: design, implement and completion of a project with a guidance of a lecturer. The project consist of literature research, processing (and carrying out experiments). At the end of the semester, students present their results/ projects.
Required readings:	1. ASM Handbook, Vol. 9, Metallography and Microstructures 2. ASM Handbook, Vol. 10, Materials Characterization 3. ASM Handbook, Vol. 21, Composites
Recommended readings:	
Assessment methods and criteria:	

OTHERS

Course Description	
Course title:	**Theory of heat transport**
Neptun code:	MAKETT273M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l. 2p.
Number of credits; hours per week	8; 8
Name and position of lecturer:	Dr. Pál Lukács, assistant professor
Contact of lecturer:	toth.pal@uni-miskolc.hu
Prerequisite course(s):	

Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 1
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	Several industrial-scale and laboratory-scale applications are based on heat transmission processes. The concept of heat transfer implies the transmission of thermal energy between different types of media. The driving force of these processes is temperature difference. The second law of thermodynamics assumes that part of the internal energy of a higher-temperature medium (thermodynamic system) is normally transmitted to a lower-temperature medium (thermodynamic system). In other words, heat never “passes” spontaneously from a cooler medium to a warmer one. While thermodynamics describe thermal equilibration and transformation processes, the theoretical models of heat transfer are concerned with dynamic processes, where certain forms of thermal energy defined by special parameters are converted to other forms of thermal energy defined by different parameters. Quantitatively, heat transfer is effected in accordance with the law of conservation of energy, which means that for closed systems, energy output equals to the initial energy input (the energy absorbed by the system).
Required readings:	Maximilian Lackner, Franz Winter, Avinash K. Agarwal: Handbook of Combustion, 5 Volume Set, Wiley VCH Verlag GmbH, 2010. Kreith, F.; Boehm, R.F.; et. al. “Heat and Mass Transfer” Mechanical Engineering Handbook, Ed. Frank Kreith, CRC Press LLC, 1999. Frank P. Incropera, David P. DeWitt, Theodore L. Bergman, Adrienne S. Lavine: Fun-damentals of Heat and Mass Transfer, Wiley, 2001. Maximilian Lackner, Arpad Palotas, Franz Winter: Combustion: From Basics to Applications, Wiley VCH Verlag GmbH, 2013.
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Planning of energetical systems**
Neptun code:	MAKETT274M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l. 2p.
Number of credits; hours per week	8; 8
Name and position of lecturer:	Dr. Pál Lukács, assistant professor
Contact of lecturer:	toth.pal@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 2
Requirements (exam/practical mark/signature/report, essay)	practical mark
Course objectives (50-100 words):	The three levels and the distinctive characteristics of energy management and strategic planning: national/regional level, production level, supply and consumption level. National/regional tools of global energy planning (integrated resource planning), energy models (e.g. WORLD3, NEMS, etc.) – theoretical framework and practical analysis via simulation tools (Stevens) and problem-solving excercises, calculations. At the EU/State level, the possible roles, intervention potentials, direct and indirect incentives in the shaping of energy policies are discussed (legislation, funding, project financing). At the production level, technical-economic (thermoeconomic)efficiency assessment methods are surveyed. Based on these methods, investors can choose among ”best design” procedures for the planning, construction and optimal operation of their future power/heat plants. At the supply and consumption level, the energy management criteria of public and residential institutions are presented (strategies and requirements, tools and functions).
Required readings:	Franz Beneke, Bernhard Nacke, Herbert Pfeifer: Handbook of thermoprocessing technologies, Vulkan Verlag Gmbh, 2012. Barrie Jenkins, Peter Mullinger: Industrial and Process Furnaces: Principles, Design and Operation, Butterworth-Heinemann, 2011. Energy Management Handbook, http://www.bsr.org/reports/bsr-energy-management-handbook.pdf C. A. Schacht: Refractories Handbook, Marcel Dekker, Inc. New York, 2004. Gerald Routschka, Hartmut Wuthnow: Pocket Manual Refractory Materials: Design, Properties and Testing, Vulkan; 3 edition, 2008.

Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Modelling of energetical tasks**
Neptun code:	MAKETT275M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l. 2p.
Number of credits; hours per week	8; 4
Name and position of lecturer:	Dr. Árpád Bence Palotás, professor
Contact of lecturer:	arpad.palotas@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 3
Requirements (exam/practical mark/signature/report, essay)	practical mark
Course objectives (50-100 words):	Theoretical foundation. Knowledge revival: thermodynamics and flow dynamics. Conservation of impulse, energy and mass. Differential equations of heat conduction. Theoretical models for the determination of heat transfer. Numerical calculation methods. Simple problem-solving tasks with possible solutions using the finite difference method. Understanding of the academic version of ANSYS FLUENT CFD-software. Aquiring the skill of how to use the software operationally: practice through simplified sample excercises and problem-solving tasks. Individual tasks for students: the validation of calculations, data recording and result analysis. If necessary, the correction or refining of input data, initial and boundary conditions, modifications to the mathematical methods and models used. Documentation and presentation of final results.
Required readings:	Hartmut Spliethoff: Power Generation from Solid Fuels, Springer-Verlag Berlin Heidelberg 2010. Franz Beneke, Bernhard Nacke, Herbert Pfeifer: Handbook of thermoprocessing technologies, Vulkan Verlag Gmbh, 2012. Kreith, F.; Boehm, R.F.; et. al. "Heat and Mass Transfer" Mechanical Engineering Handbook, Ed. Frank Kreith, CRC Press LLC, 1999. Scott Bennett: Encyclopedia of Energy, Global Media, First Edition, 2007. Yeshvant V. Deshmukh: Industrial Heating: Principles, Techniques, Materials, Applications, and Design, CRC Press, 2005.
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Theory of energetical systems**
Neptun code:	MAKETT276M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l. 2p.
Number of credits; hours per week	8; 8
Name and position of lecturer:	Dr. Pál Lukács, assistant professor
Contact of lecturer:	toth.pal@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 4
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	An overview of the different energy systems (electricity and heat production, alternative energy production, etc). Key features, energy efficiency and environmental impacts of the respective systems. The improvement potentials of energy systems in terms of environmental and energy efficiency. Complex problem solving tasks (possibly related to the topics of each student's degree thesis) with a carefully prepared "public presentation" (addressing the peer-group and the instructor).

Required readings:	Energy Management Handbook, http://www.bsr.org/reports/bsr-energy-management-handbook.pdf Barrie Jenkins, Peter Mullinger: Industrial and Process Furnaces: Principles, Design and Operation, Butterworth-Heinemann, 2011. Franz Beneke, Bernhard Nacke, Herbert Pfeifer: Handbook of thermoprocessing technologies, Vulkan Verlag Gmbh, 2012.
Recommended readings:	Hartmut Spliethoff: Power Generation from Solid Fuels, Springer-Verlag Berlin Heidelberg 2010. Kreith, F.; Boehm, R.F.; et. al. "Heat and Mass Transfer" Mechanical Engineering Handbook, Ed. Frank Kreith, CRC Press LLC, 1999.
Assessment methods and criteria:	

Course Description	
Course title:	**Metallurgy of iron and steel**
Neptun code:	MAKMÖT312M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	3l. 1p.
Number of credits; hours per week	8; 4
Name and position of lecturer:	Dr. Béla Török, associate professor
Contact of lecturer:	bela.torok@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 1
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	The steel is the most material in our life, so the iron and steel metallurgy is a very important subjects for the metallurgy engineer. The students learn about the ironmaking, cokemaking, sinterplant, basic oxygen steelmaking, electric arc furnace, secondary steelmaking, ingot and continuous casting of steel. The students visit one of most Hungarian steelworks where they meet the best technology in Hungary. In laboratory the students make steel with vacuum induction furnace and analyze the steel.
Required readings:	Best Available Techniques Reference Document on the Production of Iron and Steel, Integrated Pollution Prevention and Control (IPPC), European Commission, 2001 Reference Document on Best Available Techniques in the Ferrous Metals Processing Industry, Integrated Pollution Prevention and Control (IPPC), European Commission, 2001 www.steeluniversity.org
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Hydro- and electrometallurgy**
Neptun code:	MAKMÖT314M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l. 2p.
Number of credits; hours per week	8; 4
Name and position of lecturer:	Dr. Tamás Kékesi, professor
Contact of lecturer:	kekesi@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 2
Requirements (exam/practical mark/signature/report, essay)	exam

Course objectives (50-100 words):	The increasing role of hydro-electrometallurgy in the sustainable metals technologies, in the technical and economic development. Discussion of the chemical fundamentals and processes of characteristic techniques of aqueous chemical separation (selective leaching, precipitation, phase separation, ion exchange and solvent extraction, cathodic deposition). Introducing the development and modern applications of the technologies. Characterisation of the raw materials – mostly industrial by-products - which can be treated in this way. Examples to illustrate the hydrometallurgical treatment of primary and secondary raw materials. Introducing the conventional methods and characterisitcs of selective leaching and solution purification by valid examples (alumina production, processing of dry batteries, flue dusts, sludges) and illustrating the the tendencies in environmentally friendly nonferrous metallurgy (pressure leaching, bacterial leaching, neutral processes). Special methods of solution purification (cation exchange and anion exchange separations, solvent extraction). Metal extraction and recovery from aqueous solutions in conventional electrolysis systems and ion exchange membranes in divided cells. Examining the equilibria in solutions, stability of dissolved species and the modelling of their transformations. Application of Pourbaix-type diagrams and thermodynamic computations for the optimation of hydro-electrometallurgical operations (by the application of ROCC, HSC-Chemistry and Factsage softwares). Laboratory practices of separation techniques and applied electrochemistry). The laboratory implementation of selective precipitation, ion exchange and electrowinning and electrorefining. Work-shop practice with autoclaves at elevated temperatures.
Required readings:	Fathi Habashi: Textbook of Hydrometallurgy, Métallurgie Extractive Québec, 1999 Fathi Habashi: Principles of Extractive of Extractive Metallurgy Volume 4 Amalgam and Electrometallurgy, Métallurgie Extractive Québec, 1998 D. Pletcher, F.C. Walsh; Industrial Electrochemistry 2nd ed. Chapman & Hall, 1989
Recommended readings:	HSC Chemistry, Chemical Reaction and Equilibrium Software with extensive Thermo-chemical Database, Outokumpu Research Oy, A. Roine, 2002 Grjotheim, K. et al.: Aluminium Electrolysis, Aluminium-Verlag, Düsseldorf, 1982. Waseda, Y, Isshiki, M. (Eds.): Purification Processes and Characterisation of Ultra High Purity Metals, Springer, Berlin, 2002.
Assessment methods and criteria:	

Course Description	
Course title:	**Surface coating techologies**
Neptun code:	MAKMÖT315M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	3l. 1p.
Number of credits; hours per week	8; 4
Name and position of lecturer:	Dr. Tamás Török, professor
Contact of lecturer:	fektt@gold.uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 3
Requirements (exam/practical mark/signature/report, essay)	exam

Course objectives (50-100 words):	Role and function of the coating techniques and technologies in the metallurgical processes and manufacturing of metals products in due consideration of materials saving, environmental protection, and sustainability. Modern techniques of surface cleaning, pre-treatments of surfaces, coating technologies and the post-treatments techniques. Batch type coating technologies: physical vapor deposition (PVD), chemical vapor deposition (CVD) and other vacuum deposition techniques; thermal spaying, vitreous glassy enameling, hot dip galvanizing, electroplating and other chemical and electrochemical surface modification methods. Developing coating layers via continuous deposition techniques: thin film deposition from gases; continuous zinc coating of wire and steel sheets/plates in hot dip galvanizing lines; continuous electroplating of metals and alloys. Coating systems with organic/polymer base film forming materials: lacquering, painting, electrophoretic deposition and coil coating, powder coating. Novel combinations of film forming materials and coating systems; novel techniques and technologies in the formation of surface layers. Quality control and testing of materials and coatings. Laboratory exercises and plant visits and field training at industrial sites and workshops.
Required readings:	Surface Engineering, ASM Handbook, Vol.5, ASM International, Materials park, OH, 1994
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Theory and modern technologies of casting**
Neptun code:	MAKMÖT316M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l. 2p.
Number of credits; hours per week	8; 4
Name and position of lecturer:	Dr. Dániel Molnár
Contact of lecturer:	daniel.molnar@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 4
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	Heat transfer between mould and metal. Calculation of solidification time. Solidification process of metalls and its alloys. Fluidity of metalls, flowability. Fluid dinamics of liquid metals. Shrinkage, gas porosity. Residual stresses.
Required readings:	D.M. Stefanescu et al.: ASM Handbook, Casting, Butterworth & Heinemann, 1998 Jesper Hattel: Numerical modelling of casting processes, Technical University of Denmark, 2001 John Campbell: Castings, University of Birmingham, 2000 E. A. Brandes et al.: Smithells Light Metals Handbook, Butterworth & Heinemann, 1998
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Investigation of fine structure**
Neptun code:	MAKFKT354M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l.
Number of credits; hours per week	4; 2
Name and position of lecturer:	Dr. Valéria Mertinger, professor
Contact of lecturer:	femvali@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 1
Requirements (exam/practical mark/signature/report, essay)	exam

Course objectives (50-100 words):	Crystallography, Electron wave interaction with material, X ray interaction with material, Scanning electron microscopy I., Scanning electron microscopy II., Microprobe, Using X Ray I., Using X ray II., Using X ray III., Transmission electron microscopy I., Transmission electron microscopy II., Transmission electron microscopy III., Project presentation.
Required readings:	Materials and Structures, Jason Weiss, ISSN: 1871-6873 (electronic version)
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Nanotechnologies I.**
Neptun code:	MAKFKT353M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l.
Number of credits; hours per week	4; 2
Name and position of lecturer:	Dr. Péter Baumli, associate professor
Contact of lecturer:	peter.baumli@gmail.com
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 2
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	In the course we discuss teh processing of the nanomaterials. The main topics of this course: Introduction to the colloid chemistry, and interfacial chemistry; Gaseous phase technologies: CVD, CVC, PVD, Carbon nanotube, carbon fiber preparation technologies. Preparation of the metallic nanoparticles, paramagnetic metal- oxid nanoparticles. Preparation of Metal matrix composite (MMCs).
Required readings:	C. Brechignac, P. Houdy és M. Lahmani, Nanomaterials and Nanochemistry, Springer-Verlag, Berlin, Heidelberg, 2007. K.S. Birdi: Surface and Colloid chemistry
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Microscope aided picture analysis**
Neptun code:	MAKFKT355M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2p.
Number of credits; hours per week	4; 2
Name and position of lecturer:	Dr. Péter Barkóczy, associate professor
Contact of lecturer:	peter.barkoczy@gmail.com
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 3
Requirements (exam/practical mark/signature/report, essay)	practical mark
Course objectives (50-100 words):	During the courses and presentations students become proficient users of the optical microscope. They become aquanted not only with the use of the machines, also with their structure and their optical basics. They get to know the basics and application of optical contrast technologies. They learn the basics of microscopic imaging. Based on these student will be able to prepare images with great quality, with appropriate exposition and contrastrate. They learn the basics for the use of digital contrast techniques and computer based image analysis. After the course students will be able to make snaps proper digital image analysis.

Required readings:	"Introduction to Electron Microscopy". FEI Company. p. 15. Retrieved 12 December 2012. Antonovsky, A. (1984). "The application of colour to sem imaging for increased definition O'Keefe MA, Allard LF. Sub-Ångstrom Electron Microscopy for Sub-Ångstrom Nano Metrology (pdf). Information Bridge: DOE Scientific and Technical Information – Sponsored by OSTI. Retrieved 2010-01-31
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Nanotechnologies II.**
Neptun code:	MAKFKT356M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l.
Number of credits; hours per week	4; 2
Name and position of lecturer:	Dr. Péter Baumli, associate professor
Contact of lecturer:	peter.baumli@gmail.com
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 2
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	
Required readings:	Introduction to the colloid chemistry, and interfacial chemistry; Preparation of the metallic nanoparticles, paramagnetic metal- oxid nanoparticles by microemulsion and coprecipitation. Carbon nanotube, carbon fiber preparation technologies and its application. The modification of the carbon nanotubes. Preparation of the metallic foam by molten salt. Preparation of the metallic nanoparticles, paramagnetic metal- oxid nanoparticles. Preparation of Metal matrix composite (MMCs). Fabrication of the porous materials.
Recommended readings:	C. Brechignac, P. Houdy és M. Lahmani, Nanomaterials and Nanochemistry, Springer-Verlag, Berlin, Heidelberg, 2007.
Assessment methods and criteria:	

Course Description	
Course title:	**Water, air and soil quality protection I.**
Neptun code:	MAKKEM277M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	1l. 1p.
Number of credits; hours per week	4; 2
Name and position of lecturer:	Dr. Olivér Bánhidi, honorary professor
Contact of lecturer:	banhidio@freemail.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 1
Requirements (exam/practical mark/signature/report, essay)	exam

Course objectives (50-100 words):	General characterisation of water, dissolved substances (gases and solids) and suspended materials in the water. Water pollutants. Characterisation of the water quality (BOI, KOI, dissolved oxygen, water hardness, heavy metal ions, etc.). Grouping and classification of the water pollutants and those of cleaning procedures. (primary,secondary, tertiary treatments, classification of the pollutants based on their phase and degree of dispersion). Review of gas-, and solid air-pollutants. The formation of SO2, NOx and CO. Air-and gas cleaning devices applied in the industry so that the emission of air-pollutants could be reduced. The most wide-spread technologies featured with reduced SO2, Nox, CO, carbon-hydrogenes and other organic substance emission. Phases of the soil, the chemical and mineral composition of the phases. The types and characteristics of soil. The main principles of chemical processes taking place in the soil: dissolution, protolytic processes, redox reactions, sorption and ion exchange.
Required readings:	H.Peavy-D.Rowe-G.Tchobanoglous. Environmental Engineering, McGraw-Hill Book,NY, 1985. H.H.Hahn. Wasserzechnologie, Springer-Verlag, Berlin-Heidelberg-New York, 1987. Ronald A. Bailey, Herbert M. Clark, James P. Ferris, Sonja Krause and Robert L. Strong, Chemistry of the Environment, 2002 Elsevier Inc., ISBN: 978-0-12-073461-0,Edited by: Janick F. Artiola, Ian L. Pepper and Mark L. Brusseau, Environmental Monitoring and Characterization, 2004 Elsevier Inc., ISBN: 978-0-12-064477-3
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Waste-utilization**
Neptun code:	MAKKEM276M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l.
Number of credits; hours per week	4; 2
Name and position of lecturer:	Dr. Ferenc Mogyoródy
Contact of lecturer:	fkmmf@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 2
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	Domestic waste situation and comparison with foreign examples. The legal framework for harmonization with EU. waste incorporation of related laws. Waste types, waste management principles. Technical and technological solutions for waste management. Legislation of recovery special wastes (oils , batteries, packaging, construction and demolition waste electrical and electronic waste , etc) . Mass balances, input-output matrices, their methods of calculation. Hazardous substances and their management. Life Cycle Assessment. Waste Register. The shipping and handling methods. Licensing procedures, responsibilities of the authorities. Incineration of waste , disposal services. Environmental impact studies, the substantive requirements of the rules of procedure. Waste Treatment acceptance of public. The importance of agriculture, chemical and metallurgical technologies in waste utilisation.
Required readings:	Integrated solid waste management: engineering principles and management issues. [book]:G Tchobanoglous, H Theisen, S Vigil - 1993 - cabdirect.org Waste management models and their application to sustainable waste management: AJ Morrissey, J Browne - Waste management, 2004 – Elsevier Hazardous waste management: MD LaGrega, PL Buckingham, JC Evans - 1994 - osti.gov Natural systems for waste management and treatment. [book]: SC Reed, RW Crites, EJ Middlebrooks - 1995 - cabdirect.org What life-cycle assessment does and does not do in assessments of waste management: T Ekvall, G Assefa, A Björklund, O Eriksson… - Waste Management, 2007 - Elsevier
Recommended readings:	
Assessment methods and criteria:	

Course Description	
Course title:	**Water, air and soil quality protection II.**

Neptun code:	MAKKEM278M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	1l. 1p.
Number of credits; hours per week	4; 2
Name and position of lecturer:	Dr. Olivér Bánhidi, honorary professor
Contact of lecturer:	banhidio@freemail.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 3
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	Mechanical methods of water treatment. Coagulants and flocculants and their application to water purification. Flotation procedures in the water purification. water treatment and preparation. Disinfection and oxidation using chlorine and ozone. Review of a waste-water treatment plant of an industrial company. Review of the measurements and tests performed in the laboratories of the regional organisation of the Hungarian Environmental Protection Authority. Origin of dusts, their grain-size distribution, electric properties, the surface phenomena relating to them. Determination of the dust content of the atmosphere. The industrial dust precipitator devices. Wet gas prurification methods and equipment used for this purpose. The typesof the soil pollution, macro and micro-pollutants. The transformation and transport of the pollutants in the soil. The self-cleaning ability of the soil. The methods of soild decontamination. General problems of the soil protection. Photoflocculation. Adsorption, adsorbents and their application to water purification. Ion exchange and its application to the process of water softening and water purification. Precipitation, removal of the heavy metal ions from water. Reduction of the water hardness.. Anaerobe and aerobe processes in the water purification. Lake purification. Membrane processes: reverse osmosis, ultrafiltering, elektrolytic dialysis. Basic processes of drinking
Required readings:	H.Peavy-D.Rowe-G.Tchobanoglous. Environmental Engineering, McGraw-Hill Book,NY, 1985. H.H.Hahn. Wasserzechnologie, Springer-Verlag, Berlin-Heidelberg-New York, 1987. Ronald A. Bailey, Herbert M. Clark, James P. Ferris, Sonja Krause and Robert L. Strong, Chemistry of the Environment, 2002 Elsevier Inc., ISBN: 978-0-12-073461-0 Edited by: Janick F. Artiola, Ian L. Pepper and Mark L. Brusseau, Environmental Monitoring and Characterization, 2004 Elsevier Inc., ISBN: 978-0-12-064477-3
Recommended readings:	NicolasP.Cheremisinoff PhD. Handbook of Air Pollution Prevention and Control, 2002 Elsevier Inc. ISBN 0-7506-7499-7
Assessment methods and criteria:	

Course Description	
Course title:	**Impact assessment, risk evaluation and environmental conditions**
Neptun code:	MAKKEM279M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l.
Number of credits; hours per week	4; 2
Name and position of lecturer:	
Contact of lecturer:	
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-6	s, 4
Requirements (exam/practical mark/signature/report, essay)	exam

Course objectives (50-100 words):	The goals of the course: basically the analysis of environmental media, analisys of wastes and otherwise available methods for data processing from the environment to the extent that they will be able to engineer practicing. Environmental Assessment. Monitoring systems. Global , regional, local studies and their evaluation. Mathematical and statistical analysis of the measurement results. Assessment of the state of environments based on composition measurements and indicator phenomenas. Mathematical methods for evaluating the datas. Environmental Modeling : Environmental information systems. Modeling the spread of pollution. Analysis of the situation. Environmental modeling, modeling of environmental changes. Learning techniques and they use to identify and mitigate the risk of human health and the environment. Hazard identification, exposure - effect (dose / concentration-response / effect) analyzes, exposure assessment and risk characterization. The risk environment. Risk Assessment Report. Probabilistic characterization of the risk of technological systems. Examining the spread of contamination in the environment.
Required readings:	Handbook of Chemical Risk Assessment: Health Hazards to Humans, Plants, and Animals, Three Volume Set [book]: R Eisler - 2010 - books.google.com Toxicokinetic modeling and its applications in chemical risk assessment: ME Andersen - Toxicology letters, 2003 – Elsevier Uncertainties in chemical risk assessment: results of a European benchmark exercise: A Amendola, S Contini, I Ziomas - Journal of Hazardous Materials, 1992 – Elsevier
Recommended readings:	General principles for risk assessment of living modified organisms: lessons from chemical risk assessment: A Ryan, C Sendashonga - Environ. Biosafety Res, 2003 - Cambridge Univ Press The perception of risk. [book]: PE Slovic - 2000 - psycnet.apa.org
Assessment methods and criteria:	

Course Description	
Course title:	**Archaeometallurgy I.**
Neptun code:	MAKMÖT321M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l.
Number of credits; hours per week	4; 2
Name and position of lecturer:	Dr. Béla Török, associate professor
Contact of lecturer:	bela.torok@ui-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 1
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	Definition of archaeometallurgy as an interdisciplinary study. Connections with metallurgy, archaeology, archaeometry and materials science. Introducing some of the scientific techniques commonly used in archaeometallurgy. Archaeometallurgy of copper and its alloys. Archaeometallurgy of other non-ferrous metals (lead, tin, silver, gold). Description of ancient metalworking processes and technologies from the Bronze Age to the 18th century (smelting, refining, alloying, casting, coating and working of metals). Technological capabilities of several nations and their technical-cultural affinities. Definition and description of finds of non-ferrous metalworking such as metal tools, scrap metal, slags, residues, hearth lining, crucibles and moulds.
Required readings:	R. F. Tylecote.: A History of Metallurgy. Second Edition, The Institute of Materials, London, 1992. Bayley, J. – Dungworth, D. – Paynter, S. (eds.): Archaeometallurgy. Centre for Archaeology Guidelines. English Heritage, London, 2001/1 P. T. Craddock: Early metal mining and production. Edinburgh University Press; Smithsonian University Press, Edinburgh, Washington, DC, 1995.
Recommended readings:	R. F. Tylecote: The Prehistory of Metallurgy in the British Isles. Institute of Metals, London, 1986.
Assessment methods and criteria:	Signature: personal home work about optional topic (10-15 pages) for maximum 10 points. Above 5 points: allowed to exam. On exam: written essay or oral presentation on a topic for maximum 10 points. Total maximum: 20 points. Final mark: 11 – 12 points: satisfactory; 13 – 14 points: medium; 15 – 17 points: good; 18 and above: excellent.

Course Description	
Course title:	**Archaeometallurgy II.**
Neptun code:	MAKMÖT322M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2l.
Number of credits; hours per week	4; 2
Name and position of lecturer:	Dr. Béla Török, associate professor
Contact of lecturer:	bela.torok@ui-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 2
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	Archaeometallurgy of iron. Types, structures and sites of period raw materials (bog ores, meadow ores, lake ores, etc.). Description of ancient ironworking processes and technologies from the beginnings times to the 18th century (ore preroasting, charcoal burning, smelting, bloom purification, forging). Similarities and differences between the bloomery process and blast furnace process. Technological capabilities of several nations and their technical-cultural affinities. Definition and description of finds of ironworking such as iron tools, bloom fragment, slags, charcoal, furnace fragment, breast-wall, twyer. General principles, function and typological system of ancient and medieval bloomery furnaces and early blast furnaces. Physico-chemical and metallurgical processes in the bloomery furnace. Iron production, iron yield and the minimal iron content of bog iron ores regarding early medieval bloomery iron smelting.
Required readings:	Tylecote, R.F.: A History of Metallurgy. The Institute of Materials. London. The Bath Press, Avon. 1992. ISBN 1-902653-79-3 Buchwald V.F.: Iron and steel in ancient times. Historisk-filosofiske Skrifter 29, Academy of Sciences and Letters, Copenhagen, 2005. ISBN 87-7304-308-7 Pleiner, R.: Iron In Archaeology – The European Bloomery Smelters. Archeologickỳ ústav AV ČR, Praha, 2000. ISBN 80-86124-26-6
Recommended readings:	Bayley, J. – Dungworth, D. – Paynter, S. (eds.): Archaeometallurgy. Centre for Archaeology Guidelines. English Heritage, London, 2001/1. Buchwald V.F.: Iron, steel and cast iron before Bessemer. Historisk-filosofiske Skrifter 32, The Royal Danish Academy of Sciences and Letters, Copenhagen, 2008. Pleiner, R.: Iron In Archaeology – Early European Blacksmith. Archeologickỳ ústav AV ČR, Praha, 2006.
Assessment methods and criteria:	Signature: personal home work about optional topic (10-15 pages) for maximum 10 points. Above 5 points: allowed to exam. On exam: written essay or oral presentation on a topic for maximum 10 points. Total maximum: 20 points. Final mark: 11 – 12 points: satisfactory; 13 – 14 points: medium; 15 – 17 points: good; 18 and above: excellent.

Course Description	
Course title:	**Archaeoleogical aspects of archaeometallurgy**
Neptun code:	MAKMÖT323M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	1l. 1p.
Number of credits; hours per week	4; 2
Name and position of lecturer:	Dr. György Lengyel, assistant professor
Contact of lecturer:	bolengyu@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	a, 3
Requirements (exam/practical mark/signature/report, essay)	exam
Course objectives (50-100 words):	The course provides information on the multidisciplinary archaeological science. It presents the archaeological periods in Hungary, with special attention to the "metal ages", the methodology in archaeological research of metal finds including conservation and restoration. Discussed also the typology of metal objects through periods of archaeology, including from simple tools to jewellry, touching upon issues of archeometallurgy.

Required readings:	R. F. Tylecote (1992) A History of Metallurgy, 2nd edn, Institute of Materials Bayley, Crossley, and Ponting (2008) „Metals and Metalworking"Historical Metallurgy Society Occasional Publication no. 6, Roberts, B.W. and Thornton, C.P. (eds.) (2014)
Recommended readings:	Archaeometallurgy in Global Perspective: Methods and Syntheses. New York: Springer. David Killick, Thomas Fenn (2012) Archaeometallurgy: The Study of Preindustrial Mining and Metallurgy. In Annual Review of Anthropology Vol. 41: 559-575.
Assessment methods and criteria:	Signature: test writing (20 questions, at least 11 good answers = allowed to exam) Exam: oral presentation on two questions.

Course Description	
Course title:	**Examination of finds and experimental archaeometallurgy**
Neptun code:	MAKMÖT324M
Status: core, specialization, optional, other:	specialization
Type : lecture/seminar (practical)	2p.
Number of credits; hours per week	4; 2
Name and position of lecturer:	Dr. Béla Török, associate professor
Contact of lecturer:	bela.torok@uni-miskolc.hu
Prerequisite course(s):	
Language of the course:	English
Suggested semester: autumn /spring, 1-4	s, 4
Requirements (exam/practical mark/signature/report, essay)	practical mark
Course objectives (50-100 words):	Archaeometallurgical finds include ores, slags, fragments of hearth or furnace structure, crucibles, moulds, metal stock, scrap and waste, iron or stone metalworking tools (hammers, tongs, etc) and metal tools and artefacts. Topics of the course: fieldwork methods (fieldwalking, geophysical survey), sampling, laboratory investigations including chemical (XRF, ICP, EDX, AAS, etc.) and mineral (XRD, XRPD) analysis as well as materials testing (X-ray, OM, SEM). Practice and model of making assessment report on the basis of examinations. Identification of archeometallurgical finds. Definition, basic properties and possibilities of experimental archaeometallurgy. Experimental methods (authentic or laboratory conditions). Typical examples of reconstructed smelting, forging and casting experiments.
Required readings:	M. Pollard - C. Heron: Archaeological Chemistry. Cambridge, 1996. S.L. Olsen: Scanning Electron Microscopy in Archaeology. British Archaeological Reports International Series 452. 1988. R. Dungworth - R.C.P. Doonan: Accidental and experimental archaeometallurgy. Historical Metallurgy Society Occasional Publication 7, (2010) 2014.
Recommended readings:	J. Bayley – D. Dungworth – S. Paynter (eds.): Archaeometallurgy. Centre for Archaeology Guidelines. English Heritage, London, 2001/1. S. Macready – F. H. Thompson: Archaeological field survey in Britain and abroad. London, 1985
Assessment methods and criteria:	Signature: test writing (20 questions, at least 11 good answers) Maximum 20 points. Task for practical mark: personal home work about optional topic (10-15 pages) for maximum 20 points. Total maximum: 40 points. Final mark: 21 – 25 points: satisfactory; 26 – 30 points: medium; 31 – 35 points: good; 36 and above: excellent.