Study plan

Name of study plan: Fyzikální inženýrství materiálů

Faculty/Institute/Others:
Department:
Branch of study guaranteed by the department: Welcome page
Garantor of the study branch:
Program of study: Physical Engineering of Materials
Type of study: Follow-up master full-time
Required credits: 0
Elective courses credits: 120
Sum of credits in the plan: 120
Note on the plan:

Name of the block: Compulsory courses in the program
Minimal number of credits of the block: 0
The role of the block: P

Code of the group: NMSPFIM1
Name of the group: MDP P_FIMN 1st year
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 17 courses
Credits in the group: 0
Note on the group:

Code	Name of the course / Name of the group of courses *(in case of groups of courses the list of codes of their members)* *Tutors,* ***authors*** *and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
14ADYK	**Applied Dynamics of Continuum** *Hanuš Seiner* ***Hanuš Seiner*** *Hanuš Seiner (Gar.)*	Z,ZK	2	2P+0C	Z	P
14EM2	**Elasticity 2** *Vladislav Oliva, Aleš Materna* ***Vladislav Oliva*** *Vladislav Oliva (Gar.)*	Z,ZK	4	2P+2C	Z	P
14EXME	**Experimental Mechanics** *Ondřej Kovářík* ***Ondřej Kovářík*** *Ondřej Kovářík (Gar.)*	KZ	5	2P+2C	Z	P
14FRAM	**Fractography and Microanalysis** *Petr Haušild, Jan Siegl* ***Jan Siegl*** *Jan Siegl (Gar.)*	Z,ZK	2	2P+0C	L	P
14FPU	**Functional Surface Modifications** *Ondřej Kovářík, Radek Mušálek* ***Ondřej Kovářík*** *Ondřej Kovářík (Gar.)*	KZ	2	2P+0C	L	P
14FM1	**Physical Metallurgy 1** *Miroslav Karlík* ***Miroslav Karlík*** *Miroslav Karlík (Gar.)*	Z,ZK	4	2P+2C	Z	P
14FME2	**Physical Metallurgy 2** *Petr Haušild* ***Petr Haušild*** *Petr Haušild (Gar.)*	Z,ZK	3	2P+0C		P
14FM2	**Physical Metallurgy 2** *Petr Haušild* ***Petr Haušild*** *Petr Haušild (Gar.)*	Z,ZK	2	2P+0C	L	P
14LM1	**Fracture Mechanics 1** *Jiří Kunz* ***Jiří Kunz*** *Jiří Kunz (Gar.)*	Z,ZK	2	2P+0C	Z	P
14LM2	**Fracture Mechanics 2** *Jiří Kunz* ***Jiří Kunz*** *Jiří Kunz (Gar.)*	Z,ZK	2	2P+0C	L	P
14MMIM	**Micromechanical and Indentation Methods** *Jaroslav Čech* ***Jaroslav Čech*** *Jaroslav Čech (Gar.)*	KZ	2	1P+1C	L	P
14MIP1	**Miniprojects 1** *Ondřej Kovářík, Jaroslav Čech* ***Jaroslav Čech*** *Jaroslav Čech (Gar.)*	KZ	3	0P+2C	Z	P
14MIP2	**Miniprojects 2** *Ondřej Kovářík, Jaroslav Čech* ***Jaroslav Čech*** *Jaroslav Čech (Gar.)*	KZ	3	0P+2C	L	P
14PLA	**Plasticity** *Vladislav Oliva, Aleš Materna* ***Vladislav Oliva*** *Vladislav Oliva (Gar.)*	Z,ZK	3	2P+1C	L	P
14PM	**Computational Mechanics** *Aleš Materna* ***Aleš Materna*** *Aleš Materna (Gar.)*	KZ	2	2P+0C	L	P
14VUSM1	**Research Project 1** *Aleš Materna* ***Aleš Materna*** *Aleš Materna (Gar.)*	Z	6	0+6	1	P
14VUSM2	**Research Project 2** *Aleš Materna* ***Aleš Materna*** *Aleš Materna (Gar.)*	KZ	8	0+8	2	P

14UM	**Fatigue of Materials** *Ondřej Kovářík, Hynek Lauschmann* ***Hynek Lauschmann*** *Hynek Lauschmann (Gar.)*	KZ	2	2P+0C	L	P

Characteristics of the courses of this group of Study Plan: Code=NMSPFIM1 Name=MDP P_FIMN 1st year

14ADYK	Applied Dynamics of Continuum	Z,ZK	2

Abstract: Natural, free, transient and forced vibrations of continuous systems (strings, rods, beams, membranes, plates, shells), equations of motion, method of solution and basic dynamical characteristics.

14EM2	Elasticity 2	Z,ZK	4

Abstract: The course deals with an advanced theory of elasticity - buckling of long straight columns, torsion of non-circular shafts, various plane stress and plane strain problems, Kirchhoff's plates, shells. The emphasis is made on methods and results relevant to general solid mechanics and materials science applications.

14EXME	Experimental Mechanics	KZ	5

Abstract: The course represents an overview of current experimental methods and procedures in the following fields: - experimental analysis of the main mechanical quantities (stress, displacement, force, torque, pressure, etc.), - experimental dynamics (shakers, vibration transducers, damping, balancing, vibroanalysis). Every four hours lecture is equivalently divided into theoretical and experimental. The presented methods are immediately demonstrated in the laboratory in groups of maximally three students organized as research teams. Each team ha a tutor at hand to guide the students through the experimental task and to solve an eventual problems. One student is designated a team leader and is responsible for the proper fulfilment of the experimental task and prepares a experimental report at home and hands it back in one month time.

14FRAM	Fractography and Microanalysis	Z,ZK	2

Abstract: Basic and accessible methods of experimental materials characterization in microvolume, their application in the study of material properties and in the domain of failure analysis. Relationships between processing technology, mechanical properties and failure processes.

14FPU	Functional Surface Modifications	KZ	2

Abstract: Categories of surface modification according to technology and application. Surface modification and coating technologies. Process parameters and their influence on surface and coating properties. Coating materials, deposition technologies and application areas. Additive manufacturing and near net shape deposition. Visits to thermal spray labs. Laboratory preparation and characterization of coatings.

14FM1	Physical Metallurgy 1	Z,ZK	4

Abstract: Basic principles of metal physics, acquired in preceding courses, are extended to the applications in the field of processing and thermo mechanical treatment of different structural materials. Furthermore, an introduction to degradation processes as radiation damage, oxidation and corrosion is given.

14FME2	Physical Metallurgy 2	Z,ZK	3

Abstract: The course is based on previously acquired general physical and physical metallurgical knowledge and applies this knowledge to real systems such as Fe-C and Fe-X-C, multicomponent Fe and Ni -based alloys, etc., which are the basis of steels and special structural materials. Since the Physical Metallurgy 2 builds on the previous, more theoretically oriented courses of Metal Physics and Physical Metallurgy 1, added emphasis is placed on applications of real systems in engineering.

14FM2	Physical Metallurgy 2	Z,ZK	2

Abstract: The course is based on previously acquired general physical and physical metallurgical knowledge and applies this knowledge to real systems such as Fe-C and Fe-X-C, multicomponent Fe and Ni -based alloys, etc., which are the basis of steels and special structural materials. Since the Physical Metallurgy 2 builds on the previous, more theoretically oriented courses of Metal Physics and Physical Metallurgy 1, added emphasis is placed on applications of real systems in engineering.

14LM1	Fracture Mechanics 1	Z,ZK	2

Abstract: Mechanisms and modes of fracture. Stress and strain field in the vicinity of notch or crack tip. Parameters of linear elastic fracture mechanics. Total energy balance approach. Fracture toughness of materials and crack stability examination. Application in research and engineering practice.

14LM2	Fracture Mechanics 2	Z,ZK	2

Abstract: Parameters of non-linear elastic-plastic fracture mechanics. Fracture toughness of structural alloys in the case of general yielding. Fatigue of materials - fundamentals, fatigue crack propagation under various conditions, application of fracture mechanics. Case studies.

14MMIM	Micromechanical and Indentation Methods	KZ	2

Aim of the course is to present to the students the methods of determination of materials mechanical properties in the micro-volume. The course will focus mainly on the penetration methods (classical hardness tests and nanoindentation, small punch test, scratch tests, etc.). In-situ methods which enable direct observation of micromechanical tests (micropillar compression, microcantilever bending, etc.) in electron microscopes forms the second topic of the course. The practical measurements are the essential part of the course. At the end of the course, the students should be able to choose the appropriate technique (taking into account the advantages and limitations of individual methods) for characterization of the properties of investigated materials/components.

14MIP1	Miniprojects 1	KZ	3

Abstract: The course should complete and extend knowledge gained in theoretical courses. The students carry out two miniprojects of a larger extent on the up to date topic from the field of physical metallurgy, fracture mechanics, material preparation, mechanical characterization of materials, microscopy, non-destructive testing etc. Under the supervision of the lecturer, the students get the theoretical basis on the given topic, they will carry out the measurements and perform a critical analysis of the results. The evaluation will be based on the submitted measurement reports.

14MIP2	Miniprojects 2	KZ	3

Abstract: The course should complete and extend knowledge gained in theoretical courses. The students carry out two miniprojects of a larger extent on the up to date topic from the field of physical metallurgy, fracture mechanics, material preparation, mechanical characterization of materials, microscopy, non-destructive testing etc. Under the supervision of the lecturer, the students get the theoretical basis on the given topic, they will carry out the measurements and perform a critical analysis of the results. The evaluation will be based on the submitted measurement reports.

14PLA	Plasticity	Z,ZK	3

Abstract: Introduction to plasticity of materials and structures in terms of classical continuum mechanics. The first part contains the general incremental theory: yield criteria, strain hardening, loading criterion, flow rule and corresponding physical equations including the deformation theory. Then engineering solutions of elastic-plastic tension, bending, torsion and plastic collapse of bars, beams and pressure vessels are presented. The second part is devoted to methods and knowledge useful for material science: stress concentration and plastic deformation around notches and cracks, limit theorems and their applications to estimation of the plastic collapse, localization of plastic deformation before the fracture, differences between plasticity in plane stress and strain, elastic-plastic response to cyclic load.

14PM	Computational Mechanics	KZ	2

Abstract: Theory and application of the finite element method in the mechanics of deformable bodies. Lectures are accompanied by model examples which aims to demonstrate the basic principles of building the correct numerical models.

14VUSM1	Research Project 1	Z	6

Abstract: The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.

14VUSM2	Research Project 2	KZ	8

Abstract: The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.

14UM	Fatigue of Materials	KZ	2

Abstract: Lectures are concerned with explanation of conditions, causes and mechanisms of fatigue damage, as well as material fatigue characteristics, diagrams, equations and computational algorithms.

Code of the group: NMSPFIM2
Name of the group: MDP P_FIMN 2nd year
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 9 courses
Credits in the group: 0
Note on the group:

Code	Name of the course / Name of the group of courses *(in case of groups of courses the list of codes of their members)* *Tutors,* ***authors*** *and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
14ANP	**Failure Analysis** *Jan Siegl, Jaroslav Čech* ***Jan Siegl*** *Jan Siegl (Gar.)*	ZK	3	2P+0C	L	P
14DPSM1	**Diploma Thesis 1** *Vladislav Oliva, Petr Haušild* ***Petr Haušild*** *Vladislav Oliva (Gar.)*	Z	10	0+10	3	P
14DPSM2	**Diploma Thesis 2** *Vladislav Oliva, Petr Haušild* ***Petr Haušild*** *Petr Haušild (Gar.)*	Z	20	0+20	4	P
14NDT	**Nondestructive Diagnostics** *Ondřej Kovářík* ***Ondřej Kovářík*** *Ondřej Kovářík (Gar.)*	Z	2	2P+0C	Z	P
14NEKM	**Non-metallic Naterials** *Miroslav Karlík* ***Miroslav Karlík*** *Miroslav Karlík (Gar.)*	Z,ZK	2	2P+0C	Z	P
14PP	**Pre-diploma Experience** *Petr Haušild* ***Petr Haušild*** *Petr Haušild (Gar.)*	Z	4	2XT	Z	P
14SMT	**Seminar - New Trends in Materials Engineering** *Aleš Materna, Jiří Kunz* ***Jiří Kunz*** *Jiří Kunz (Gar.)*	Z	3	2P+1C	Z	P
14SFM	**Seminar Physics of materials** *Hynek Lauschmann, Karel Tesař* ***Hynek Lauschmann*** *Karel Tesař (Gar.)*	KZ	5	0P+4C	L	P
11VDM	**Intrinsic Dynamics of Materials** *Hanuš Seiner* ***Hanuš Seiner*** *Hanuš Seiner (Gar.)*	ZK	3	2+0	Z	P

Characteristics of the courses of this group of Study Plan: Code=NMSPFIM2 Name=MDP P_FIMN 2nd year

14ANP	Failure Analysis	ZK	3

Abstract: Lectores summarise basic methods of fractographic analysis used both in the research of new materials and technologies and in the failure analysis of machines and structures. The first part of lectures deals with historical background of fractography in relation with experimental techniques. The second part deals with detail description of different methodological procedures of fractographic analysis. All methods are illustrated by the help of case studies realised in fractographic laboratory of the Department of Materials.

14DPSM1	Diploma Thesis 1	Z	10

Abstract: The diploma project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.

14DPSM2	Diploma Thesis 2	Z	20

Abstract: The diploma project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.

14NDT	Nondestructive Diagnostics	Z	2

Abstract: The course is devoted to acquaintance with theoretical and practical grounding and applications of nondestructive testing (NDT), evaluation (NDE), and inspection (NDI, SHM) of materials and structures. Besides the standard NDT methods, the lectures also deal with the newest NDT/NDE procedures (acoustic emission, nonlinear ultrasonic spectroscopy and tomography, etc.). The education is completed by practical laboratory training in selected methods and also by excursions into industrial companies working on NDT/NDE.

14NEKM	Non-metallic Naterials	Z,ZK	2

Abstract: This course explains the structure and basic properties of important non-metallic materials, such as ceramics, glass, polymers and composites. These materials can be used as single material for construction, they can form protective coatings or they may be used as components for the functionally graded materials.

14PP	Pre-diploma Experience	Z	4

Abstract: Working experience on the given subject in the laboratory.

14SMT	Seminar - New Trends in Materials Engineering	Z	3

Abstract: New research findings in the field of research and development of new materials and technologies, degradation processes, experimental methods etc. Presentations of partial results of the students master theses.

14SFM	Seminar Physics of materials	KZ	5

Abstract: Reiteration and replenishment of knowledge from the main profile subjects. Case studies.

11VDM	Intrinsic Dynamics of Materials	ZK	3

The course gives an introductory overview of dynamical phenomena taking place in the materials, with the main focus laid on the elastic wave propagation (and its interaction with the microstructure), dynamic plasticity, phase transition fronts kinetics, and dynamic fracture mechanics.

Name of the block: Compulsory elective courses
Minimal number of credits of the block: 0
The role of the block: PV

Code of the group: NMSPFIMPV1
Name of the group: MDP P_FIMN Required optional courses 1st year

Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 1 course
Credits in the group: 0
Note on the group: Student si volí alespoň 1 předmět

Code	Name of the course / Name of the group of courses *(in case of groups of courses the list of codes of their members)* *Tutors, **authors** and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
01ASM	**Application of Statistical Methods** *Tomáš Hobza **Tomáš Hobza** Tomáš Hobza (Gar.)*	KZ	2	2+0		PV
01VAMB	**Variational Methods B** *Michal Beneš **Michal Beneš** Michal Beneš (Gar.)*	KZ	2	2	Z	PV

Characteristics of the courses of this group of Study Plan: Code=NMSPFIMPV1 Name=MDP P_FIMN Required optional courses 1st year

01ASM	Application of Statistical Methods	KZ	2
The course focuses on applications of selected methods of statistical data analysis to concrete problems including their solutions using statistical software. Namely we will deal with: hypotheses tests about parameters of normal distribution, nonparametric methods, contingency tables, linear regression and correlation, analysis of variance.			
01VAMB	Variational Methods B	KZ	2
The course is devoted to the methods of classical variational calculus - functional extrema by Euler equations, second functional derivative, convexity or monotonicity. Further, it contains investigation of quadratic functional, generalized solution, Sobolev spaces and variational problem for elliptic PDE's.			

Name of the block: Elective courses
Minimal number of credits of the block: 0
The role of the block: V

Code of the group: NMSPFIMV
Name of the group: MDP P_FIMN Optional courses
Requirement credits in the group:
Requirement courses in the group:
Credits in the group: 0
Note on the group:

Code	Name of the course / Name of the group of courses *(in case of groups of courses the list of codes of their members)* *Tutors, **authors** and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
11AND	**Applied Neutron Diffractometry** *Monika Kučeráková, Stanislav Vratislav **Monika Kučeráková** Stanislav Vratislav (Gar.)*	ZK	2	2	Z	V
11DAN	**Diffraction Analysis of Mechanical Stress** *Nikolaj Ganev, Ivo Kraus **Nikolaj Ganev** Nikolaj Ganev (Gar.)*	ZK	2	2	Z	V
11FPPL	**Physics of Solid State Phase Transitions** *Jiří Hlinka **Jiří Hlinka** Jiří Hlinka (Gar.)*	ZK	2	2	L	V
11FPOR	**Physics of Surfaces and Interfaces** *Ladislav Kalvoda Ladislav Kalvoda (Gar.)*	ZK	2	2P+0C	Z	V
11NAMA	**Nanomaterials - Preparation and Characteristics** *Irena Kratochvílová **Irena Kratochvílová** Irena Kratochvílová (Gar.)*	Z,ZK	2	2+0	L	V
11NMV	**Neutronography in Material Research** *Monika Kučeráková, Stanislav Vratislav **Monika Kučeráková** Monika Kučeráková (Gar.)*	ZK	2	2	L	V
11SMAM	**Smart Materials and Their Applications** *Zdeněk Potůček, Petr Sedlák **Zdeněk Potůček** Zdeněk Potůček (Gar.)*	ZK	2	2+0	L	V
01SKE	**System Reliability and Clinical Experiments** *Václav Kůs **Václav Kůs** Václav Kůs (Gar.)*	KZ	3	2+0	L	V
01SUP	**Start-up Project** *Přemysl Rubeš **Přemysl Rubeš** Přemysl Rubeš (Gar.)*	KZ	2	2P+0C		V
14UAOB	**Introduction to image analysis** *Hynek Lauschmann **Hynek Lauschmann** Hynek Lauschmann (Gar.)*	KZ	2	1P+1C		V
12PYTHN	**Scientific Programming in Python** *Jakub Urban, Pavel Váchal **Pavel Váchal** Pavel Váchal (Gar.)*	Z	2	0+2	L	V

Characteristics of the courses of this group of Study Plan: Code=NMSPFIMV Name=MDP P_FIMN Optional courses

11AND	Applied Neutron Diffractometry	ZK	2
This lecture introduces the neutron diffraction method as the method used in solid state physics research and the materials sciences. The basic principles of the nuclear and magnetic neutron scattering are given, as well as the comparative properties to the X-ray method. The basic concept of this method is illustrated by many practical examples.			
11DAN	Diffraction Analysis of Mechanical Stress	ZK	2
Course description: The course contains the fundamentals of diffraction stress analysis with a strong emphasis on the illustrations of the capability of X-ray diffraction to solve engineering problems.			

11FPPL	Physics of Solid State Phase Transitions	ZK	2
A number of interesting properties of crystalline materials are directly related or significantly influenced by occurrence of specific phase transitions. The purpose of this course is to provide unifying view on various types phase transitions encountered in solid state physics, with the emphasize on continuous symmetry braking phase transitions.			
11FPOR	Physics of Surfaces and Interfaces	ZK	2
Description is provided of basic thermodynamic properties, atomary and electronic structure of surfaces and interfaces. The physical models valid for bulk sysstems are juxtaposed with the changes due to introduction of new surface/interface. The theoretical treatment is followed by overview of experimental techniques applied to preparation of surface structures and to study of chemical composition and structural arrangement of the latter. In addition, brief overview is given of simulation approaches suitable for analysis and prediction of properties of selected systems. All the subjects are demonstrated on praktical exaples of case studies.			
11NAMA	Nanomaterials - Preparation and Characteristics	Z,ZK	2
The course describes methods of preparation of nanomaterials, their structure, specific properties and applications. The properties of carbon and silicon nanobodies and layers will be analyzed in detail. The aim of the subject is to explain the relationships between physical / chemical properties of nanoparticulate materials and their main structural features.			
11NMV	Neutronography in Material Research	ZK	2
Neutron diffraction is a powerful method for a detailed understanding of the static and dynamic properties on atomic scale of materials in many field of sciences and industry. This course introduces to the fundamental principles of nuclear and magnetic scattering and penetration of thermal neutrons. From this point of view the following aspects are very important: sample size in relation to industrial scaling, neutron penetration though machinable materials (and consequent case of construction of environmental chambers), neutron atomic contrast and magnetic scattering possibilities. Examples of the different neutron scattering techniques are given.			
11SMAM	Smart Materials and Their Applications	ZK	2
Smart or responsive materials have one or more properties, such as shape, conductivity or color, that can be dramatically and reversibly altered by changes in some external conditions. The properties responding to external stimuli (heat, stress, electric field, light) influences what types of applications the smart material can be used for. The number of their applications is growing steadily. Passive and active vibration damping, airbag sensors, acoustic transducers, precision positioners, miniature ultrasonic motors, vascular stents, eyeglass frames, cellular phone antennas, light sensitive glasses or photochromic and thermochromic clothes could serve as a few examples. Lectures are focused on physical properties, experimental methods of investigation and possible application of color changing materials, light emitting materials, piezoelectric materials, conducting polymers, dielectric elastomers, ferroelectric materials and shape-memory materials. Attention is also paid to the effect of phase transitions on physical properties of smart materials and to their numerical simulations.			
01SKE	System Reliability and Clinical Experiments	KZ	3
The main goal of the subject is to provide the mathematical principles of reliability theory and techniques of survival data analysis, reliability of component systems, asymptotic methods for reliability, concept of experiments under censoring and their processing in clinical trials (life-time models). The techniques are illustrated and tested within practical examples originating from lifetime material experiments and clinical trials.			
01SUP	Start-up Project	KZ	2
14UAOB	Introduction to image analysis	KZ	2
The aim of the lecture is an introduction to selected basic methods of image processing and analysis with an emphasis on the applications to material engineering. Solutions of particular tasks built in Matlab are presented.			
12PYTHN	Scientific Programming in Python	Z	2
The aim of this course is to learn the fundamentals of the modern Python programming language with a focus on scientific computing. Emphasis is placed on effective solutions to real problems. The course is performed in an interactive form of practical exercises, whose topics are tailored to the content of other subjects, study level, and student theses. Students are also involved in ongoing research. In the introductory part of the course, students learn the basic features of Python?from basic types to object oriented or functional programming. The greater part of the course focuses on specific features of Python for scientific programming. Presented are the main numerical libraries NumPy, SciPy and the Matplotlib graphics library. We show how to generate efficient code, how to combine Python with other languages, what tools are available.			

List of courses of this pass:

Code	Name of the course	Completion	Credits
01ASM	Application of Statistical Methods	KZ	2
The course focuses on applications of selected methods of statistical data analysis to concrete problems including their solutions using statistical software. Namely we will deal with: hypotheses tests about parameters of normal distribution, nonparametric methods, contingency tables, linear regression and correlation, analysis of variance.			
01SKE	System Reliability and Clinical Experiments	KZ	3
The main goal of the subject is to provide the mathematical principles of reliability theory and techniques of survival data analysis, reliability of component systems, asymptotic methods for reliability, concept of experiments under censoring and their processing in clinical trials (life-time models). The techniques are illustrated and tested within practical examples originating from lifetime material experiments and clinical trials.			
01SUP	Start-up Project	KZ	2
01VAMB	Variational Methods B	KZ	2
The course is devoted to the methods of classical variational calculus - functional extrema by Euler equations, second functional derivative, convexity or monotonicity. Further, it contains investigation of quadratic functional, generalized solution, Sobolev spaces and variational problem for elliptic PDE's.			
11AND	Applied Neutron Diffractometry	ZK	2
This lecture introduces the neutron diffraction method as the method used in solid state physics research and the materials sciences. The basic principles of the nuclear and magnetic neutron scattering are given, as well as the comparative properties to the X-ray method. The basic concept of this method is illustrated by many practical examples.			
11DAN	Diffraction Analysis of Mechanical Stress	ZK	2
Course description: The course contains the fundamentals of diffraction stress analysis with a strong emphasis on the illustrations of the capability of X-ray diffraction to solve engineering problems.			
11FPOR	Physics of Surfaces and Interfaces	ZK	2
Description is provided of basic thermodynamic properties, atomary and electronic structure of surfaces and interfaces. The physical models valid for bulk sysstems are juxtaposed with the changes due to introduction of new surface/interface. The theoretical treatment is followed by overview of experimental techniques applied to preparation of surface structures and to study of chemical composition and structural arrangement of the latter. In addition, brief overview is given of simulation approaches suitable for analysis and prediction of properties of selected systems. All the subjects are demonstrated on praktical exaples of case studies.			
11FPPL	Physics of Solid State Phase Transitions	ZK	2
A number of interesting properties of crystalline materials are directly related or significantly influenced by occurrence of specific phase transitions. The purpose of this course is to provide unifying view on various types phase transitions encountered in solid state physics, with the emphasize on continuous symmetry braking phase transitions.			

11NAMA	Nanomaterials - Preparation and Characteristics	Z,ZK	2
The course describes methods of preparation of nanomaterials, their structure, specific properties and applications. The properties of carbon and silicon nanobodies and layers will be analyzed in detail. The aim of the subject is to explain the relationships between physical / chemical properties of nanoparticulate materials and their main structural features.			
11NMV	Neutronography in Material Research	ZK	2
Neutron diffraction is a powerful method for a detailed understanding of the static and dynamic properties on atomic scale of materials in many field of sciences and industry. This course introduces to the fundamental principles of nuclear and magnetic scattering and penetration of thermal neutrons. From this point of view the following aspects are very important: sample size in relation to industrial scaling, neutron penetration though machinable materials (and consequent case of construction of environmental chambers), neutron atomic contrast and magnetic scattering possibilities. Examples of the different neutron scattering techniques are given.			
11SMAM	Smart Materials and Their Applications	ZK	2
Smart or responsive materials have one or more properties, such as shape, conductivity or color, that can be dramatically and reversibly altered by changes in some external conditions. The properties responding to external stimuli (heat, stress, electric field, light) influences what types of applications the smart material can be used for. The number of their applications is growing steadily. Passive and active vibration damping, airbag sensors, acoustic transducers, precision positioners, miniature ultrasonic motors, vascular stents, eyeglass frames, cellular phone antennas, light sensitive glasses or photochromic and thermochromic clothes could serve as a few examples. Lectures are focused on physical properties, experimental methods of investigation and possible application of color changing materials, light emitting materials, piezoelectric materials, conducting polymers, dielectric elastomers, ferroelectric materials and shape-memory materials. Attention is also paid to the effect of phase transitions on physical properties of smart materials and to their numerical simulations.			
11VDM	Intrinsic Dynamics of Materials	ZK	3
The course gives an introductory overview of dynamical phenomena taking place in the materials, with the main focus laid on the elastic wave propagation (and its interaction with the microstructure), dynamic plasticity, phase transition fronts kinetics, and dynamic fracture mechanics.			
12PYTHN	Scientific Programming in Python	Z	2
The aim of this course is to learn the fundamentals of the modern Python programming language with a focus on scientific computing. Emphasis is placed on effective solutions to real problems. The course is performed in an interactive form of practical exercises, whose topics are tailored to the content of other subjects, study level, and student theses. Students are also involved in ongoing research. In the introductory part of the course, students learn the basic features of Python?from basic types to object oriented or functional programming. The greater part of the course focuses on specific features of Python for scientific programming. Presented are the main numerical libraries NumPy, SciPy and the Matplotlib graphics library. We show how to generate efficient code, how to combine Python with other languages, what tools are available.			
14ADYK	Applied Dynamics of Continuum	Z,ZK	2
Abstract: Natural, free, transient and forced vibrations of continuous systems (strings, rods, beams, membranes, plates, shells), equations of motion, method of solution and basic dynamical characteristics.			
14ANP	Failure Analysis	ZK	3
Abstract: Lectores summarise basic methods of fractographic analysis used both in the research of new materials and technologies and in the failure analysis of machines and structures. The first part of lectures deals with historical background of fractography in relation with experimental techniques. The second part deals with detail description of different methodological procedures of fractographic analysis. All methods are illustrated by the help of case studies realised in fractographic laboratory of the Department of Materials.			
14DPSM1	Diploma Thesis 1	Z	10
Abstract: The diploma project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.			
14DPSM2	Diploma Thesis 2	Z	20
Abstract: The diploma project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.			
14EM2	Elasticity 2	Z,ZK	4
Abstract: The course deals with an advanced theory of elasticity - buckling of long straight columns, torsion of non-circular shafts, various plane stress and plane strain problems, Kirchhoff's plates, shells. The emphasis is made on methods and results relevant to general solid mechanics and materials science applications.			
14EXME	Experimental Mechanics	KZ	5
Abstract: The course represents an overview of current experimental methods and procedures in the following fields: - experimental analysis of the main mechanical quantities (stress, displacement, force, torque, pressure, etc.), - experimental dynamics (shakers, vibration transducers, damping, balancing, vibroanalysis). Every four hours lecture is equivalently divided into theoretical and experimental. The presented methods are immediately demonstrated in the laboratory in groups of maximally three students organized as research teams. Each team ha a tutor at hand to guide the students through the experimental task and to solve an eventual problems. One student is designated a team leader and is responsible for the proper fulfilment of the experimental task and prepares a experimental report at home and hands it back in one month time.			
14FM1	Physical Metallurgy 1	Z,ZK	4
Abstract: Basic principles of metal physics, acquired in preceding courses, are extended to the applications in the field of processing and thermo mechanical treatment of different structural materials. Furthermore, an introduction to degradation processes as radiation damage, oxidation and corrosion is given.			
14FM2	Physical Metallurgy 2	Z,ZK	2
Abstract: The course is based on previously acquired general physical and physical metallurgical knowledge and applies this knowledge to real systems such as Fe-C and Fe-X-C, multicomponent Fe and Ni -based alloys, etc., which are the basis of steels and special structural materials. Since the Physical Metallurgy 2 builds on the previous, more theoretically oriented courses of Metal Physics and Physical Metallurgy 1, added emphasis is placed on applications of real systems in engineering.			
14FME2	Physical Metallurgy 2	Z,ZK	3
Abstract: The course is based on previously acquired general physical and physical metallurgical knowledge and applies this knowledge to real systems such as Fe-C and Fe-X-C, multicomponent Fe and Ni -based alloys, etc., which are the basis of steels and special structural materials. Since the Physical Metallurgy 2 builds on the previous, more theoretically oriented courses of Metal Physics and Physical Metallurgy 1, added emphasis is placed on applications of real systems in engineering.			
14FPU	Functional Surface Modifications	KZ	2
Abstract: Categories of surface modification according to technology and application. Surface modification and coating technologies. Process parameters and their influence on surface and coating properties. Coating materials, deposition technologies and application areas. Additive manufacturing and near net shape deposition. Visits to thermal spray labs. Laboratory preparation and characterization of coatings.			
14FRAM	Fractography and Microanalysis	Z,ZK	2
Abstract: Basic and accessible methods of experimental materials characterization in microvolume, their application in the study of material properties and in the domain of failure analysis. Relationships between processing technology, mechanical properties and failure processes.			
14LM1	Fracture Mechanics 1	Z,ZK	2
Abstract: Mechanisms and modes of fracture. Stress and strain field in the vicinity of notch or crack tip. Parameters of linear elastic fracture mechanics. Total energy balance approach. Fracture toughness of materials and crack stability examination. Application in research and engineering practice.			
14LM2	Fracture Mechanics 2	Z,ZK	2
Abstract: Parameters of non-linear elastic-plastic fracture mechanics. Fracture toughness of structural alloys in the case of general yielding. Fatigue of materials - fundamentals, fatigue crack propagation under various conditions, application of fracture mechanics. Case studies.			

14MIP1	Miniprojects 1	KZ	3
Abstract: The course should complete and extend knowledge gained in theoretical courses. The students carry out two miniprojects of a larger extent on the up to date topic from the field of physical metallurgy, fracture mechanics, material preparation, mechanical characterization of materials, microscopy, non-destructive testing etc. Under the supervision of the lecturer, the students get the theoretical basis on the given topic, they will carry out the measurements and perform a critical analysis of the results. The evaluation will be based on the submitted measurement reports.			
14MIP2	Miniprojects 2	KZ	3
Abstract: The course should complete and extend knowledge gained in theoretical courses. The students carry out two miniprojects of a larger extent on the up to date topic from the field of physical metallurgy, fracture mechanics, material preparation, mechanical characterization of materials, microscopy, non-destructive testing etc. Under the supervision of the lecturer, the students get the theoretical basis on the given topic, they will carry out the measurements and perform a critical analysis of the results. The evaluation will be based on the submitted measurement reports.			
14MMIM	Micromechanical and Indentation Methods	KZ	2
Aim of the course is to present to the students the methods of determination of materials mechanical properties in the micro-volume. The course will focus mainly on the penetration methods (classical hardness tests and nanoindentation, small punch test, scratch tests, etc.). In-situ methods which enable direct observation of micromechanical tests (micropillar compression, microcantilever bending, etc.) in electron microscopes forms the second topic of the course. The practical measurements are the essential part of the course. At the end of the course, the students should be able to choose the appropriate technique (taking into account the advantages and limitations of individual methods) for characterization of the properties of investigated materials/components.			
14NDT	Nondestructive Diagnostics	Z	2
Abstract: The course is devoted to acquaintance with theoretical and practical grounding and applications of nondestructive testing (NDT), evaluation (NDE), and inspection (NDI, SHM) of materials and structures. Besides the standard NDT methods, the lectures also deal with the newest NDT/NDE procedures (acoustic emission, nonlinear ultrasonic spectroscopy and tomography, etc.). The education is completed by practical laboratory training in selected methods and also by excursions into industrial companies working on NDT/NDE.			
14NEKM	Non-metallic Naterials	Z,ZK	2
Abstract: This course explains the structure and basic properties of important non-metallic materials, such as ceramics, glass, polymers and composites. These materials can be used as single material for construction, they can form protective coatings or they may be used as components for the functionally graded materials.			
14PLA	Plasticity	Z,ZK	3
Abstract: Introduction to plasticity of materials and structures in terms of classical continuum mechanics. The first part contains the general incremental theory: yield criteria, strain hardening, loading criterion, flow rule and corresponding physical equations including the deformation theory. Then engineering solutions of elastic-plastic tension, bending, torsion and plastic collapse of bars, beams and pressure vessels are presented. The second part is devoted to methods and knowledge useful for material science: stress concentration and plastic deformation around notches and cracks, limit theorems and their applications to estimation of the plastic collapse, localization of plastic deformation before the fracture, differences between plasticity in plane stress and strain, elastic-plastic response to cyclic load.			
14PM	Computational Mechanics	KZ	2
Abstract: Theory and application of the finite element method in the mechanics of deformable bodies. Lectures are accompanied by model examples which aims to demonstrate the basic principles of building the correct numerical models.			
14PP	Pre-diploma Experience	Z	4
Abstract: Working experience on the given subject in the laboratory.			
14SFM	Seminar Physics of materials	KZ	5
Abstract: Reiteration and replenishment of knowledge from the main profile subjects. Case studies.			
14SMT	Seminar - New Trends in Materials Engineering	Z	3
Abstract: New research findings in the field of research and development of new materials and technologies, degradation processes, experimental methods etc. Presentations of partial results of the students master theses.			
14UAOB	Introduction to image analysis	KZ	2
The aim of the lecture is an introduction to selected basic methods of image processing and analysis with an emphasis on the applications to material engineering. Solutions of particular tasks built in Matlab are presented.			
14UM	Fatigue of Materials	KZ	2
Abstract: Lectures are concerned with explanation of conditions, causes and mechanisms of fatigue damage, as well as material fatigue characteristics, diagrams, equations and computational algorithms.			
14VUSM1	Research Project 1	Z	6
Abstract: The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.			
14VUSM2	Research Project 2	KZ	8
Abstract: The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.			

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