Study plan

Name of study plan: Inženýrství pevných látek

Faculty/Institute/Others:
Department: Department of Solid State Engineering
Branch of study guaranteed by the department: Solid State Engineering
Garantor of the study branch: doc. Ing. Ladislav Kalvoda, CSc.
Program of study: Applications of Natural Sciences
Type of study: Follow-up master full-time
Required credits: 95
Elective courses credits: 25
Sum of credits in the plan: 120
Note on the plan:

Name of the block: Compulsory courses of the specialization
Minimal number of credits of the block: 95
The role of the block: PO

Code of the group: NMSIPLPP1
Name of the group: NMSIPL - povinné předměty 1. ročník
Requirement credits in the group: In this group you have to gain at least 44 credits
Requirement courses in the group: In this group you have to complete at least 10 courses
Credits in the group: 44
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
11DIEL	**Physics of Dielectrics** *Zdeněk Bryknar Zdeněk Bryknar (Gar.)*	ZK	3	2	L	PO
11KOV	**Physics of Metals** *Hanuš Seiner Hanuš Seiner (Gar.)*	ZK	3	2	Z	PO
11MAGN	**Physics of Magnetic Materials**	ZK	3	2	L	PO
11POL1	**Semiconductor Physics 1**	ZK	6	4	Z	PO
11SMX1	**Diploma Seminar 1** ***Petr Kolenko***	Z	3	2	Z	PO
11SMI1	**Diploma Seminar 1** ***Stanislav Vratislav***	Z	3	0+2	Z	PO
11SMX2	**Diploma Seminar 2** ***Petr Kolenko***	Z	3	2	L	PO
11SMI2	**Diploma Seminar 2** ***Stanislav Vratislav***	Z	3	0+2	L	PO
11TPL1	**Solid State Theory 1** *Jaroslav Hamrle, Štefan Zajac Ladislav Kalvoda (Gar.)*	ZK	6	4+0	Z	PO
11TPL2	**Solid State Theory 2** *Jaroslav Hamrle, Štefan Zajac Jaroslav Hamrle (Gar.)*	ZK	3	2+0	L	PO
11VUIP1	**Research Project 1** *Ladislav Kalvoda Ladislav Kalvoda (Gar.)*	Z	6	0+6	Z	PO
11VUIP2	**Research Project 2** *Ladislav Kalvoda Ladislav Kalvoda (Gar.)*	KZ	8	0+8	L	PO

Characteristics of the courses of this group of Study Plan: Code=NMSIPLPP1 Name=NMSIPL - povinné předměty 1. ročník

11DIEL	Physics of Dielectrics	ZK	3
Electrical, thermal, and mechanical properties of dielectrics and switching of polarization in ferroelectrics are described in details. Interaction of electromagnetic field with dielectric materials is studied in a wide frequency range from point of view of classical and quantum physics.			
11KOV	Physics of Metals	ZK	3
The purpose of this lecture is to introduce the undergraduate students to the study of the physical properties of metals and alloys.			
11MAGN	Physics of Magnetic Materials	ZK	3
Origin of magnetic moment. Magnetic susceptibility of materials. Diamagnetism and paramagnetism. Materials with spontaneous magnetization - ferromagnets, antiferromagnets, ferrimagnets. Domain structure and magnetization process. Magnetic relaxation and resonance phenomena.			

11POL1	Semiconductor Physics 1	ZK	6
Lectures give overview of fundamental physical phenomena used for design and operation of semiconductor elements. Physics of electric, galvanomagnetic, thermoelectric, thermomagnetic, photoelectric and optical properties of intrinsic and doped semiconductors is explained in detail with respect to possibilities of their effective modification and optimization. Considerable attention is also paid to explanation of the properties of P-N junction and metal-semiconductor contact.			
11SMX1	Diploma Seminar 1	Z	3
The subject is recommended for preparation of the diploma thesis solution. It consists of lectures of research workers, advisors, postgraduates and undergraduates			
11SMI1	Diploma Seminar 1	Z	3
The subject is recommended for preparation of the diploma thesis solution. It consists of lectures of research workers, advisors, postgraduates and undergraduates.			
11SMX2	Diploma Seminar 2	Z	3
The subject is recommended for preparation of the diploma thesis solution. It consists of lectures of research workers, advisors, postgraduates and undergraduates			
11SMI2	Diploma Seminar 2	Z	3
The subject is recommended for preparation of the diploma thesis solution. It consists of lectures of research workers, advisors, postgraduates and undergraduates.			
11TPL1	Solid State Theory 1	ZK	6
Types of bonds in solids. Symmetry of crystalline solids. Vibrations of crystalline lattice and its thermal properties. Band electron structure of crystalline solids. Localized states of electrons in nonideal solids.			
11TPL2	Solid State Theory 2	ZK	3
Electric, magnetic and thermal properties of itinerant electrons in solids, Bolzmann kinetic equation, transport and optical phenomena in solids			
11VUIP1	Research Project 1	Z	6
11VUIP2	Research Project 2	KZ	8

Code of the group: NMSIPLPP2
Name of the group: NMSIPL - povinné předměty 2. ročník
Requirement credits in the group: In this group you have to gain at least 51 credits
Requirement courses in the group: In this group you have to complete at least 9 courses
Credits in the group: 51
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
11DPIP1	**Master Thesis 1** *Ladislav Kalvoda, Stanislav Vratislav Ladislav Kalvoda (Gar.)*	Z	10	0+10	Z	PO
11DPIP2	**Master Thesis 2** *Ladislav Kalvoda Ladislav Kalvoda (Gar.)*	Z	20	0+20	L	PO
11FYPO1	**Surface Physics 1** *Ladislav Kalvoda Ladislav Kalvoda (Gar.)*	ZK	2	2+0	Z	PO
11FYPO2	**Surface Physics 2** *Ladislav Kalvoda Ladislav Kalvoda (Gar.)*	ZK	2	2+0	L	PO
11MME	**Mathematical Models in Economics**	KZ	2	1+1	Z	PO
11MEM1	**Modern Experimental Methods** *Jan Drahokoupil **Jan Drahokoupil** Stanislav Vratislav (Gar.)*	Z	5	5	Z	PO
11PRAK	**Professional Practice**	Z	5	2t	Z	PO
11OPT	**Optical Properties of Solids** *Zdeněk Bryknar Zdeněk Bryknar (Gar.)*	ZK	3	2	Z	PO
11SIKL	**Computer Simulation of Condensed Matter** *Ladislav Kalvoda, Jaroslava Jakoubková, Petr Sedlák **Jan Drahokoupil** Ladislav Kalvoda (Gar.)*	ZK	4	2+2	Z,L	PO
11SMI3	**Diploma Seminar 3** ***Stanislav Vratislav***	Z	3	0+2	Z	PO
11SMX3	**Diploma Seminar 3** *Štefan Zajac, Petr Kolenko **Petr Kolenko** Petr Kolenko (Gar.)*	Z	3	2	Z	PO
11SMX4	**Diploma Seminar 4** *Štefan Zajac, Petr Kolenko **Petr Kolenko** Petr Kolenko (Gar.)*	Z	3	2	L	PO
11SMI4	**Diploma Seminar 4** ***Stanislav Vratislav***	Z	3	0+2	L	PO

Characteristics of the courses of this group of Study Plan: Code=NMSIPLPP2 Name=NMSIPL - povinné předměty 2. ročník

11DPIP1	Master Thesis 1	Z	10
On the basis of the assignment and under the supervision of the supervisor, the student prepares an individually assigned topic for 2 semesters.			
11DPIP2	Master Thesis 2	Z	20
On the basis of the assignment and under the supervision of the supervisor, the student prepares an individually assigned topic for 2 semesters.			

11FYPO1	Surface Physics 1	ZK	2

1. Historical remarks. Geometrical and thermodynamic approach to a surface (fractal surfaces, Gibbs model of ideal surface, surface tension and specific surface free energy, surface relaxation and surface reconstruction). 2. Vacuum and clean surface preparation techniques: Surface contamination, UHV systems, vacuum pumps, vacuum gauges, special techniques of clean surface preparation. 3. Surface chemical composition. Surface sensitivity of traditional "bulk" methods. Spectroscopy of secondary electrons (SE). Characteristic features of SE energetic spectrum. 4. Electron energy analyzers. Principles of Auger electron spectroscopy (AES) and photoelectron spectroscopy (XPS). 5. Quantitative analysis of surface chemical composition. Construction of SE spectrometers. 6. Mass spectroscopy of secondary particles. SIMS: Basic theoretical aspects, quantitative analysis, assets and drawbacks. Further methods utilizing secondary particles. Construction of spectrometers and ionic sources. 7. Analysis of a depth chemical composition profile: non-destructive method based on variation of the signal registration depth, method of skew cut, surface sputtering. 8. Application of SAXS methods to chemical composition analysis. Microscopic techniques of surface composition analysis (SAEM, SMS, POSAP). 9. Surface structure. Description of 2D-periodic crystalline struktury: Direct and reciprocal lattice. Diffraction on 2D structures: Laue conditions and Ewald construction. Orientation of surface. 10. Surface sensitivity of classical methods of structure analysis. Low energy electron diffraction (LEED), reflection high energy electron diffraction (RHEED). 11. Surface-oriented X-ray diffraction techniques. Field emission electron and ion microscopy. Evanescent EM field techniques. 12. Scanning probe microscopy methods. 13. Surface extended X-ray absorption fine structure (SEXAFS). Simple theoretical prediction of surface structures: Chadi model.

11FYPO2	Surface Physics 2	ZK	2

1. Surface properties. Repetitorium of QM approach to bulk crystalline solids case of bulk materials and modifications caused by introduction of a surface. 2. Surface and the jellium model. Bloch waves and a 'step' potential. 3. Molecular orbital approach to surface states. Limiting cases of electronic surface states. 3. Surface phonons. Surface plasmon polaritons. 4. Experimental characterization of surface electronic and vibratory properties. Electronic work function. Contact potential. 5. Surface charge and electronic band bending. Semiconductor super-lattices and electronic mini-bands. 6. Preparation and properties of magnetic multi-layers. 7. Electron Energy Loss Spectroscopy (EELS): Principle, instrumentation and applications.8. Adsorption at surfaces: Physisorption, chemisorption, interactions between adsorbates, surface segregation. 9. Kinetics of adsorption and desorption. Surface chemical reactions and catalysis. 10. Coverage and ultra-thin layers. Modes of thin crystalline layer growth. 11. Experimental methods of thin layer fabrication. Physical vapor deposition (PVD). Chemical vapor deposition (CVD). 12. Principles and applications of molecular beam epitaxy (MBE). 13. Liquid phase epitaxy (LPE). Langmuir-Blodgett technique (LBT).

11MME	Mathematical Models in Economics	KZ	2

Stochastic prosesses and their classification, Poisson process, birth and death process, queueing models and their classification, graph and related terminology, cycles in a graph and their detection, the shortest and longest way through a graph, critical parth through a graph, extreme of a function of many arguments, free and constrained extremum, Lagrange multipliers, numerical methods in optimization, linear programming and its application.

11MEM1	Modern Experimental Methods	Z	5

In the course the students become acquaint with current modern experimental methods in solid phase physics and material research. The collected practical pieces of knowledge are presented at the final seminar.

11PRAK	Professional Practice	Z	5
11OPT	Optical Properties of Solids	ZK	3

This course gives an introductory into the optical properties of solids. The fundamental principles of absorption, reflection, luminescence and light propagation are discussed for a wide range of materials, including crystalline insulators, semiconductors, and metals. Classical and quantum models are used as appropriate, and the observed phenomena are discussed from point of their application.

11SIKL	Computer Simulation of Condensed Matter	ZK	4

Computer simulation in condensed-matter physics is becoming an important tool used by both experimentalist and theorists to develop new materials and technologies. Thus, solution of many practical problems can be transferred from the real to a "virtual" laboratory. During the course, students will be introduced to the theoretical background of basic computation methods and let to test the acquired knowledge in practical exercises. Each lesson is organized as a tutorial where typical problems are solved with detailed explication of the computation methods used. The course is taking place in Computer classroom of the Department of Solid State Physics. Practical demonstration and exercises are using Material Studio simulation environment (Accelrys Software Inc.).

11SMI3	Diploma Seminar 3	Z	3

The subject is recommended for preparation of the diploma thesis solution. It consists of lectures of research workers, advisors, postgraduates and undergraduates.

11SMX3	Diploma Seminar 3	Z	3

The subject is recommended for preparation of the diploma thesis solution. It consists of lectures of research workers, advisors, postgraduates and undergraduates

11SMX4	Diploma Seminar 4	Z	3

The subject is recommended for preparation of the diploma thesis solution. It consists of lectures of research workers, advisors, postgraduates and undergraduates

11SMI4	Diploma Seminar 4	Z	3

The subject is recommended for preparation of the diploma thesis solution. It consists of lectures of research workers, advisors, postgraduates and undergraduates.

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

Code of the group: NMSIPLVP
Name of the group: NMSIPL - volitelné předměty
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** *Stanislav Vratislav, Monika Kučeráková Stanislav Vratislav (Gar.)*	ZK	2	2	Z	V
11CHA	**Chemical Aspects of Solids** *Karel Knížek Karel Knížek (Gar.)*	ZK	2	2	L	V
11DAN	**Diffraction Analysis of Mechanical Stress** *Nikolaj Ganev, Ivo Kraus Nikolaj Ganev (Gar.)*	ZK	2	2	Z	V
11DMSB	**Diffraction Methods of Structural Biology** *Jan Dohnálek* ***Jan Dohnálek*** *Jan Dohnálek (Gar.)*	Z,ZK	3	2+1	L	V

11EP	**Practical Training in Electronics** *Pavel Jiroušek Pavel Jiroušek (Gar.)*	KZ	4	0+4	Z	v
11POL2	**Semiconductor Physics 2**	ZK	2	2	L	v
11FPPL	**Physics of Solid State Phase Transitions** *Ivo Kraus, Jiri Hlinka Ivo Kraus (Gar.)*	ZK	2	2	L	v
11KPS	**Construction of Semiconductor Devices** *Bruno Sopko Bruno Sopko (Gar.)*	ZK	2	2	L	v
11KO	**Metallic Oxides** *Jiří Hejtmánek Jiří Hejtmánek (Gar.)*	ZK	2	2	Z,L	v
11KVAP	**Quantum Computation** *Ladislav Andrey Ladislav Andrey (Gar.)*	ZK	2	2	L	v
11MAM	**Magnetic Materials** *Oleg Heczko* ***Oleg Heczko*** *Oleg Heczko (Gar.)*	ZK	2	2+0	Z	v
11MONA	**Molecular Nanosystems** *Irena Kratochvílová* ***Irena Kratochvílová*** *Irena Kratochvílová (Gar.)*	ZK	2	2	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** *Stanislav Vratislav, Monika Kučeráková Stanislav Vratislav (Gar.)*	ZK	2	2	L	v
11OSAL	**Optical Spectroscopy of Inorganic Solids** *Zdeněk Potůček Zdeněk Potůček (Gar.)*	ZK	2	2	L	v
11DETE	**Semicoductor Detectors** *Bruno Sopko Bruno Sopko (Gar.)*	ZK	2	2+0	L	v
11PMK1	**Macromolecular Crystallography Laboratory 1** *Petr Kolenko* ***Petr Kolenko*** *Petr Kolenko (Gar.)*	KZ	4	0+4	Z	v
11PMK2	**Macromolecular Crystallography Laboratory 2** *Petr Kolenko* ***Petr Kolenko*** *Petr Kolenko (Gar.)*	KZ	4	0+4	L	v
11PPOL	**Practical Training of Semiconductors** *Petr Levinský* ***Petr Levinský*** *Petr Levinský (Gar.)*	KZ	4	4	L	v
11PSPL	**Practical Exercises from Solid State Structure Analysis** *Monika Kučeráková, Jiří Čapek* ***Jiří Čapek*** *Jiří Čapek (Gar.)*	KZ	4	4	Z	v
11PAO	**Principles and Applications of Optical Sensors with Practical Trainings** *Jan Aubrecht Jan Aubrecht (Gar.)*	ZK	2	2	Z	v
11RTSW	**Real Time Software** *Pavel Jiroušek, Martin Dráb Pavel Jiroušek (Gar.)*	Z	3	2	L	v
11STPL	**Seminar in Solid State Theory** *Hanuš Seiner, Petr Sedlák Hanuš Seiner (Gar.)*	KZ	2	0+2	L	v
11SEM	**Scanning Electron Microscopy and Microbeam Analysis Methods** *Jaromír Kopeček* ***Jaromír Kopeček*** *Jaromír Kopeček (Gar.)*	ZK	2	2+0	Z	v
11SMAM	**Smart Materials and Their Applications** *Petr Sedlák, Zdeněk Potůček Zdeněk Potůček (Gar.)*	ZK	2	2+0	Z	v
11SMAT	**Special Semiconductor Materials and Devices** *Bruno Sopko Bruno Sopko (Gar.)*	ZK	2	2	Z	v
11SUPR	**Superconductivity and Low Temperature** *Zdeněk Janů, Martin Ledinský* ***Martin Ledinský*** *Zdeněk Janů (Gar.)*	ZK	4	4	Z	v
11TVOS	**Technology of Microwave and Optoelectronic Devices** *Bruno Sopko Bruno Sopko (Gar.)*	ZK	2	2	L	v
11PCPC	**Theory and Construction of Photovoltaic Cells** *Jiří Pfleger* ***Jiří Pfleger*** *Jiří Pfleger (Gar.)*	ZK	2	2	Z	v
11VDM	**Intrinsic Dynamics of Materials** *Hanuš Seiner* ***Hanuš Seiner*** *Hanuš Seiner (Gar.)*	ZK	3	2+0	Z	v
11VPS	**Selected Topics of Solid State Structure** *Jan Drahokoupil* ***Jan Drahokoupil*** *Jan Drahokoupil (Gar.)*	Z,ZK	2	1+1	L	v
01ZPB1	**Introduction to Computer Security 1** *Petr Vokáč* ***Petr Vokáč*** *Petr Vokáč (Gar.)*	Z	2	1+1		v
01ZPB2	**Introduction to Computer Security 2** *Petr Vokáč* ***Petr Vokáč*** *Petr Vokáč (Gar.)*	Z	2	1+1		v

Characteristics of the courses of this group of Study Plan: Code=NMSIPLVP Name=NMSIPL - volitelné předměty

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.

11CHA	Chemical Aspects of Solids	ZK	2

The purpose of this lecture is an interpretation of the chemical bonding in solids. The principle of band structure calculation is demonstrated with the help of Tight-binding method. The relations between crystal and electronic structure are manifested for selected materials.

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.

11DMSB	Diffraction Methods of Structural Biology	Z,ZK	3

Determination of 3D structure of biological macromolecules, such as proteins, nucleic acids or their complexes, by the means of physical methods is crucial for new trends in biotechnologies, biomedicine and also in basic molecular biology research. Individual methods of three-dimensional structure determination will be explained with a focus on the individual steps of single crystal diffraction analysis. Practical examples of application in biotechnologies and medicine will be discussed. The practicals will cover several basic steps leading to determination of a new molecular structure.

11EP	Practical Training in Electronics	KZ	4
Practical training in electronics gives practical experience in the design of selected electronic circuits. Students obtain basic skill in the circuit realisation. Practical training includes linear circuits, digital circuits and exercise in the programming of microprocessor control system. Students are allowed to work on the electronic problem concerning their own scientific activity.			
11POL2	Semiconductor Physics 2	ZK	2
This course is the continuation of Semiconductors Physics 1. The students gain the information about other effects in semiconductors, in semiconductor devices and in semiconductor transistors.			
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.			
11KPS	Construction of Semiconductor Devices	ZK	2
This course should be of interest to engineers who are interested in the developing and production of solid state electronic devices. The main consideration is given to the semiconductor technology and measurement methods. The primary emphasis is given to providing a quantitative knowledge of semiconductor technology which is necessary for an understanding of the operation and fabrication of diodes, transistors and other solid state devices.			
11KO	Metallic Oxides	ZK	2
Crystal structures, chemical composition and characteristic electronic properties of oxides is presented. Namely electronic and thermal transport, specific heat, thermoelectric coefficient, magnetic interactions and long range magnetic order are discussed. Phase transitions as a consequence of mutual interplay of lattice, transport and magnetic effects and metal-insulator transition tuned via chemical composition and temperature are documented. Orbital, spin and charge ordered (disordered) states are exemplified using the salient oxide families - colossal magnetoresistance manganites, high temperature superconducting cuprates and cobalt oxide thermoelectrics.			
11KVAP	Quantum Computation	ZK	2
Fundamental concepts and principles of the quantum computing; physical systems, which may be considered as expected realizations of quantum computers.			
11MAM	Magnetic Materials	ZK	2
The course deals with a broad scale of magnetic materials with emphasis on their applications. A brief introduction (referring to the former, more general theoretical courses of magnetism) is followed by description of individual effects and their usage in recent technics and technologies. We will manifest that existence of the contemporary civilization without magnetic materials is impossible. Important part of the course is devoted to introduction into measurements of various magnetic properties of solids.			
11MONA	Molecular Nanosystems	ZK	2
The main goal of the lecture is to show possibilities to use selected molecules properties in molecular nanodevices.			
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.			
11OSAL	Optical Spectroscopy of Inorganic Solids	ZK	2
Relationship between experimental data and theoretical models that allow us elucidate and predict spectroscopic properties of optical centers in solids, such as absorption spectrum, emission spectrum or decay and efficiency of luminescence, is illustrated by an example of color centers, rare-earth ions, and transition metal ions in insulators. Particular emphasis is put on influence of lattice symmetry and vibrations on spectroscopic properties of optically active centers. Attention is also paid to physical basis of the experimental techniques commonly used in optical spectroscopy of solids, to non-radiative energy transfer between adjacent centers and formation of their aggregates with distinct spectroscopic properties occurring in the case of sufficiently high concentrations of optical centers, and to optical processes operating in solid-state lasers.			
11DETE	Semicoductor Detectors	ZK	2
The lecture contents survey of detection X - rays, sensors and systems of detectors.			
11PMK1	Macromolecular Crystallography Laboratory 1	KZ	4
The subject introduces the students to practical aspects of macromolecular crystallography.			
11PMK2	Macromolecular Crystallography Laboratory 2	KZ	4
The subject introduces the students to computational approaches of macromolecular crystallography.			
11PPOL	Practical Training of Semiconductors	KZ	4
The aim of this practical training is to introduce the students with the fundamentals of semiconductors technology and with practical measurements of basic properties of semiconductor materials and devices.			
11PSPL	Practical Exercises from Solid State Structure Analysis	KZ	4
The aim of this practical training is to introduce the students the fundamentals of X-ray and neutron diffraction methods for diagnostics of structure dependant properties of solids.			
11PAO	Principles and Applications of Optical Sensors with Practical Trainings	ZK	2
This course gives an introductory into the optical sensors. The fundamental principles of absorption, luminescence and SPR sensors are discussed for a wide range of application.Course description: First part of this course gives an introductory into theory of the electromagnetic field. Second part describes the wave phenomena in mechanics and electromagnetism. Third part is devoted to introduction into atomic physics.			
11RTSW	Real Time Software	Z	3
The seminar is the introduction to the problematic of the real time software. It describes the specifics of RT software and shows commonly used solutions.			
11STPL	Seminar in Solid State Theory	KZ	2
The purpose of this lecture is to solve numerical problems of theory of solids and physics of condensed state.			
11SEM	Scanning Electron Microscopy and Microbeam Analysis Methods	ZK	2
The aim of the lecture is to familiarize students with the work on scanning electron microscope (SEM) and the possibilities of bundle analytical methods available on such devices. With regard to physical principles, the display methods, analytical methods available on SEM and sampling techniques will be analyzed. The student should be able to easily train on a specific device, after the necessary practical training to prepare a sample and choose the right technique for solving a specific problem, but also to make general orientation in the available experimental techniques.			
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.			

11SMAT	Special Semiconductor Materials and Devices	ZK	2
Course description: The lecture explain technology of compound semiconductors, typical parameters of structures and technology of devices. Technology of supergrid.			
11SUPR	Superconductivity and Low Temperature	ZK	4
The subject of course is: low temperature physics, including cooling methods, low temperature technique, and measurement of low temperatures; macroscopic quantum phenomena in quantum fluids (superfluidity and superconductivity), quantum crystals and diffusion, mesoscopic phenomena in electron systems, quantum Hall effects, Coulomb blockade and single electron transistor.			
11TVOS	Technology of Microwave and Optoelectronic Devices	ZK	2
Course description: The course is survey of microwave theory and microwave device technology.			
11PCPC	Theory and Construction of Photovoltaic Cells	ZK	2
The course is aimed to provide a theoretical background of the photovoltaic solar energy conversion. It is focused not only on the classical crystalline silicon cells but it follows also modern trends in exploiting new materials, including polymers, and new physical principles. The students will learn mathematical and theoretical background of the photovoltaic effect in various functional structures and materials. The part of the course will be dedicated to the practical and economical aspects of the application of solar cells in the distribution power networks. The life cycle assessment will provide students with better understanding of the relation between the photovoltaic cells application and environmental protection.			
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.			
11VPS	Selected Topics of Solid State Structure	Z,ZK	2
The lecture cycle focuses on the structure of solids from the point of view of the arrangement of atoms. The first part focuses on application-interesting structures from metallic materials to molecular crystals. In the second part we will look at the possibilities of observing the atomic structure using X-rays, both from the point of view of the average and the local structure. Objective of the course is also the use of special programs designed to study and analyze the structure and microstructure of solids.			
01ZPB1	Introduction to Computer Security 1	Z	2
01ZPB2	Introduction to Computer Security 2	Z	2

List of courses of this pass:

Code	Name of the course	Completion	Credits
01ZPB1	Introduction to Computer Security 1	Z	2
01ZPB2	Introduction to Computer Security 2	Z	2
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.			
11CHA	Chemical Aspects of Solids	ZK	2
The purpose of this lecture is an interpretation of the chemical bonding in solids. The principle of band structure calculation is demonstrated with the help of Tight-binding method. The relations between crystal and electronic structure are manifested for selected materials.			
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.			
11DETE	Semicoductor Detectors	ZK	2
The lecture contents survey of detection X - rays, sensors and systems of detectors.			
11DIEL	Physics of Dielectrics	ZK	3
Electrical, thermal, and mechanical properties of dielectrics and switching of polarization in ferroelectrics are described in details. Interaction of electromagnetic field with dielectric materials is studied in a wide frequency range from point of view of classical and quantum physics.			
11DMSB	Diffraction Methods of Structural Biology	Z,ZK	3
Determination of 3D structure of biological macromolecules, such as proteins, nucleic acids or their complexes, by the means of physical methods is crucial for new trends in biotechnologies, biomedicine and also in basic molecular biology research. Individual methods of three-dimensional structure determination will be explained with a focus on the individual steps of single crystal diffraction analysis. Practical examples of application in biotechnologies and medicine will be discussed. The practicals will cover several basic steps leading to determination of a new molecular structure.			
11DPIP1	Master Thesis 1	Z	10
On the basis of the assignment and under the supervision of the supervisor, the student prepares an individually assigned topic for 2 semesters.			
11DPIP2	Master Thesis 2	Z	20
On the basis of the assignment and under the supervision of the supervisor, the student prepares an individually assigned topic for 2 semesters.			
11EP	Practical Training in Electronics	KZ	4
Practical training in electronics gives practical experience in the design of selected electronic circuits. Students obtain basic skill in the circuit realisation. Practical training includes linear circuits, digital circuits and exercise in the programming of microprocessor control system. Students are allowed to work on the electronic problem concerning their own scientific activity.			
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.			
11FYPO1	Surface Physics 1	ZK	2
1. Historical remarks. Geometrical and thermodynamic approach to a surface (fractal surfaces, Gibbs model of ideal surface, surface tension and specific surface free energy, surface relaxation and surface reconstruction). 2. Vacuum and clean surface preparation techniques: Surface contamination, UHV systems, vacuum pumps, vacuum gauges, special techniques of clean surface preparation. 3. Surface chemical composition. Surface sensitivity of traditional "bulk" methods. Spectroscopy of secondary electrons (SE). Characteristic features of SE energetic spectrum. 4. Electron energy analyzers. Principles of Auger electron spectroscopy (AES) and photoelectron spectroscopy (XPS). 5. Quantitative analysis of surface chemical composition. Construction of SE spectrometers. 6. Mass spectroscopy of secondary particles. SIMS: Basic theoretical aspects, quantitative analysis, assets and drawbacks. Further methods utilizing secondary particles. Construction of spectrometers and ionic sources. 7. Analysis of a depth chemical composition profile: non-destructive method based on variation of the signal registration depth, method of skew cut, surface sputtering. 8. Application of SAXS methods to chemical composition analysis. Microscopic techniques of surface			

composition analysis (SAEM, SMS, POSAP). 9. Surface structure. Description of 2D-periodic crystalline struktury: Direct and reciprocal lattice. Diffraction on 2D structures: Laue conditions and Ewald construction. Orientation of surface. 10. Surface sensitivity of classical methods of structure analysis. Low energy electron diffraction (LEED), reflection high energy electron diffraction (RHEED). 11. Surface-oriented X-ray diffraction techniques. Field emission electron and ion microscopy. Evanescent EM field techniques. 12. Scanning probe microscopy methods. 13. Surface extended X-ray absorption fine structure (SEXAFS). Simple theoretical prediction of surface structures: Chadi model.

11FYPO2	Surface Physics 2	ZK	2

1. Surface properties. Repetitorium of QM approach to bulk crystalline solids case of bulk materials and modifications caused by introduction of a surface. 2. Surface and the jellium model. Bloch waves and a 'step' potential. 3. Molecular orbital approach to surface states. Limiting cases of electronic surface states. 3. Surface phonons. Surface plasmon polaritons. 4. Experimental characterization of surface electronic and vibratory properties. Electronic work function. Contact potential. 5. Surface charge and electronic band bending. Semiconductor super-lattices and electronic mini-bands. 6. Preparation and properties of magnetic multi-layers. 7. Electron Energy Loss Spectroscopy (EELS): Principle, instrumentation and applications.8. Adsorption at surfaces: Physisorption, chemisorption, interactions between adsorbates, surface segregation. 9. Kinetics of adsorption and desorption. Surface chemical reactions and catalysis. 10. Coverage and ultra-thin layers. Modes of thin crystalline layer growth. 11. Experimental methods of thin layer fabrication. Physical vapor deposition (PVD). Chemical vapor deposition (CVD). 12. Principles and applications of molecular beam epitaxy (MBE). 13. Liquid phase epitaxy (LPE). Langmuir-Blodgett technique (LBT).

11KO	Metallic Oxides	ZK	2

Crystal structures, chemical composition and characteristic electronic properties of oxides is presented. Namely electronic and thermal transport, specific heat, thermoelectric coefficient, magnetic interactions and long range magnetic order are discussed. Phase transitions as a consequence of mutual interplay of lattice, transport and magnetic effects and metal-insulator transition tuned via chemical composition and temperature are documented. Orbital, spin and charge ordered (disordered) states are exemplified using the salient oxide families - colossal magnetoresistance manganites, high temperature superconducting cuprates and cobalt oxide thermoelectrics.

11KOV	Physics of Metals	ZK	3

The purpose of this lecture is to introduce the undergraduate students to the study of the physical properties of metals and alloys.

11KPS	Construction of Semiconductor Devices	ZK	2

This course should be of interest to engineers who are interested in the developing and production of solid state electronic devices. The main consideration is given to the semiconductor technology and measurement methods. The primary emphasis is given to providing a quantitative knowledge of semiconductor technology which is necessary for an understanding of the operation and fabrication of diodes, transistors and other solid state devices.

11KVAP	Quantum Computation	ZK	2

Fundamental concepts and principles of the quantum computing; physical systems, which may be considered as expected realizations of quantum computers.

11MAGN	Physics of Magnetic Materials	ZK	3

Origin of magnetic moment. Magnetic susceptibility of materials. Diamagnetism and paramagnetism. Materials with spontaneous magnetization - ferromagnets, antiferromagnets, ferrimagnets. Domain structure and magnetization process. Magnetic relaxation and resonance phenomena.

11MAM	Magnetic Materials	ZK	2

The course deals with a broad scale of magnetic materials with emphasis on their applications. A brief introduction (referring to the former, more general theoretical courses of magnetism) is followed by description of individual effects and their usage in recent technics and technologies. We will manifest that existence of the contemporary civilization without magnetic materials is impossible. Important part of the course is devoted to introduction into measurements of various magnetic properties of solids.

11MEM1	Modern Experimental Methods	Z	5

In the course the students become acquaint with current modern experimental methods in solid phase physics and material research. The collected practical pieces of knowledge are presented at the final seminar.

11MME	Mathematical Models in Economics	KZ	2

Stochastic prosesses and their classification, Poisson process, birth and death process, queueing models and their classification, graph and related terminology, cycles in a graph and their detection, the shortest and longest way through a graph, critical parth through a graph, extreme of a function of many arguments, free and constrained extremum, Lagrange multipliers, numerical methods in optimization, linear programming and its application.

11MONA	Molecular Nanosystems	ZK	2

The main goal of the lecture is to show possibilities to use selected molecules properties in molecular nanodevices.

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.

11OPT	Optical Properties of Solids	ZK	3

This course gives an introductory into the optical properties of solids. The fundamental principles of absorption, reflection, luminescence and light propagation are discussed for a wide range of materials, including crystalline insulators, semiconductors, and metals. Classical and quantum models are used as appropriate, and the observed phenomena are discussed from point of their application.

11OSAL	Optical Spectroscopy of Inorganic Solids	ZK	2

Relationship between experimental data and theoretical models that allow us elucidate and predict spectroscopic properties of optical centers in solids, such as absorption spectrum, emission spectrum or decay and efficiency of luminescence, is illustrated by an example of color centers, rare-earth ions, and transition metal ions in insulators. Particular emphasis is put on influence of lattice symmetry and vibrations on spectroscopic properties of optically active centers. Attention is also paid to physical basis of the experimental techniques commonly used in optical spectroscopy of solids, to non-radiative energy transfer between adjacent centers and formation of their aggregates with distinct spectroscopic properties occurring in the case of sufficiently high concentrations of optical centers, and to optical processes operating in solid-state lasers.

11PAO	Principles and Applications of Optical Sensors with Practical Trainings	ZK	2

This course gives an introductory into the optical sensors. The fundamental principles of absorption, luminescence and SPR sensors are discussed for a wide range of application.Course description: First part of this course gives an introductory into theory of the electromagnetic field. Second part describes the wave phenomena in mechanics and electromagnetism. Third part is devoted to introduction into atomic physics.

11PCPC	Theory and Construction of Photovoltaic Cells	ZK	2

The course is aimed to provide a theoretical background of the photovoltaic solar energy conversion. It is focused not only on the classical crystalline silicon cells but it follows also modern trends in exploiting new materials, including polymers, and new physical principles. The students will learn mathematical and theoretical background of the photovoltaic effect in various functional structures and materials. The part of the course will be dedicated to the practical and economical aspects of the application of solar cells in the distribution power networks. The life cycle assessment will provide students with better understanding of the relation between the photovoltaic cells application and environmental protection.

11PMK1	Macromolecular Crystallography Laboratory 1	KZ	4

The subject introduces the students to practical aspects of macromolecular crystallography.

11PMK2	Macromolecular Crystallography Laboratory 2	KZ	4

The subject introduces the students to computational approaches of macromolecular crystallography.

11POL1	Semiconductor Physics 1	ZK	6
Lectures give overview of fundamental physical phenomena used for design and operation of semiconductor elements. Physics of electric, galvanomagnetic, thermoelectric, thermomagnetic, photoelectric and optical properties of intrinsic and doped semiconductors is explained in detail with respect to possibilities of their effective modification and optimization. Considerable attention is also paid to explanation of the properties of P-N junction and metal-semiconductor contact.			
11POL2	Semiconductor Physics 2	ZK	2
This course is the continuation of Semiconductors Physics 1. The students gain the information about other effects in semiconductors, in semiconductor devices and in semiconductor transistors.			
11PPOL	Practical Training of Semiconductors	KZ	4
The aim of this practical training is to introduce the students with the fundamentals of semiconductors technology and with practical measurements of basic properties of semiconductor materials and devices.			
11PRAK	Professional Practice	Z	5
11PSPL	Practical Exercises from Solid State Structure Analysis	KZ	4
The aim of this practical training is to introduce the students the fundamentals of X-ray and neutron diffraction methods for diagnostics of structure dependant properties of solids.			
11RTSW	Real Time Software	Z	3
The seminar is the introduction to the problematic of the real time software. It describes the specifics of RT software and shows commonly used solutions.			
11SEM	Scanning Electron Microscopy and Microbeam Analysis Methods	ZK	2
The aim of the lecture is to familiarize students with the work on scanning electron microscope (SEM) and the possibilities of bundle analytical methods available on such devices. With regard to physical principles, the display methods, analytical methods available on SEM and sampling techniques will be analyzed. The student should be able to easily train on a specific device, after the necessary practical training to prepare a sample and choose the right technique for solving a specific problem, but also to make general orientation in the available experimental techniques.			
11SIKL	Computer Simulation of Condensed Matter	ZK	4
Computer simulation in condensed-matter physics is becoming an important tool used by both experimentalist and theorists to develop new materials and technologies. Thus, solution of many practical problems can be transferred from the real to a "virtual" laboratory. During the course, students will be introduced to the theoretical background of basic computation methods and let to test the acquired knowledge in practical exercises. Each lesson is organized as a tutorial where typical problems are solved with detailed explication of the computation methods used. The course is taking place in Computer classroom of the Department of Solid State Physics. Practical demonstration and exercises are using Material Studio simulation environment (Accelrys Software Inc.).			
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.			
11SMAT	Special Semiconductor Materials and Devices	ZK	2
Course description: The lecture explain technology of compound semiconductors, typical parameters of structures and technology of devices. Technology of supergrid.			
11SMI1	Diploma Seminar 1	Z	3
The subject is recommended for preparation of the diploma thesis solution. It consists of lectures of research workers, advisors, postgraduates and undergraduates.			
11SMI2	Diploma Seminar 2	Z	3
The subject is recommended for preparation of the diploma thesis solution. It consists of lectures of research workers, advisors, postgraduates and undergraduates.			
11SMI3	Diploma Seminar 3	Z	3
The subject is recommended for preparation of the diploma thesis solution. It consists of lectures of research workers, advisors, postgraduates and undergraduates.			
11SMI4	Diploma Seminar 4	Z	3
The subject is recommended for preparation of the diploma thesis solution. It consists of lectures of research workers, advisors, postgraduates and undergraduates.			
11SMX1	Diploma Seminar 1	Z	3
The subject is recommended for preparation of the diploma thesis solution. It consists of lectures of research workers, advisors, postgraduates and undergraduates			
11SMX2	Diploma Seminar 2	Z	3
The subject is recommended for preparation of the diploma thesis solution. It consists of lectures of research workers, advisors, postgraduates and undergraduates			
11SMX3	Diploma Seminar 3	Z	3
The subject is recommended for preparation of the diploma thesis solution. It consists of lectures of research workers, advisors, postgraduates and undergraduates			
11SMX4	Diploma Seminar 4	Z	3
The subject is recommended for preparation of the diploma thesis solution. It consists of lectures of research workers, advisors, postgraduates and undergraduates			
11STPL	Seminar in Solid State Theory	KZ	2
The purpose of this lecture is to solve numerical problems of theory of solids and physics of condensed state.			
11SUPR	Superconductivity and Low Temperature	ZK	4
The subject of course is: low temperature physics, including cooling methods, low temperature technique, and measurement of low temperatures; macroscopic quantum phenomena in quantum fluids (superfluidity and superconductivity), quantum crystals and diffusion, mesoscopic phenomena in electron systems, quantum Hall effects, Coulomb blockade and single electron transistor.			
11TPL1	Solid State Theory 1	ZK	6
Types of bonds in solids. Symmetry of crystalline solids. Vibrations of crystalline lattice and its thermal properties. Band electron structure of crystalline solids. Localized states of electrons in nonideal solids.			
11TPL2	Solid State Theory 2	ZK	3
Electric, magnetic and thermal properties of itinerant electrons in solids, Bolzmann kinetic equation, transport and optical phenomena in solids			
11TVOS	Technology of Microwave and Optoelectronic Devices	ZK	2
Course description: The course is survey of microwave theory and microwave device technology.			
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.			

11VPS	Selected Topics of Solid State Structure	Z,ZK	2
The lecture cycle focuses on the structure of solids from the point of view of the arrangement of atoms. The first part focuses on application-interesting structures from metallic materials to molecular crystals. In the second part we will look at the possibilities of observing the atomic structure using X-rays, both from the point of view of the average and the local structure. Objective of the course is also the use of special programs designed to study and analyze the structure and microstructure of solids.			
11VUIP1	Research Project 1	Z	6
11VUIP2	Research Project 2	KZ	8

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