UNDERGRADUATE STUDIES

The education system in Greece is based on semesters. The academic year starts in 1st September every year and ends in 31st August the next year. It is separated in two semesters. The first (autumn) semester begins in the end of September and ends in the mid February. Classes for the second (spring) semester, resume in the mid February and last until the end of June. The exact dates are set by the Senate of the University of Patras. The programme of undergraduate studies is four years long (8 semesters) and includes lectures, laboratory training and Diploma Thesis. It is designed to cover the full breadth of materials science.

The courses offered are grouped in semesters (autumn and spring semesters). The way these courses appear in the Course Summary Table indicates the sequence of courses a student should follow according to prerequisite knowledge.

The Department's undergraduate curriculum consists of a core of basic courses (compulsory courses), which are taken by all the students and of courses (elective courses) that can be chosen by the students according to their special interests. Elective courses appear in the programme of studies from the fifth semester. There is no student quota for the elective courses, although in some cases there is a minimum requirement of three registered students for the course to be taught.

The assessment consists of a final exam at the end of the semester and in some cases mid term exams or other forms of assessment are implemented during the semester. In the laboratories, students are regularly examined, usually orally on theory and practice accompanying each experiment. Students are required to present a written account of their results at the end of each experiment. All these are taken into account in the final grade of the course associated with the particular laboratory, together with the results of the final written examination on the course.

Courses offered in the Greek language. Lecturers normally use Greek textbooks. When necessary, English textbooks can be proposed by the lecturer and can be loaned by the Departmental or the central library.

Teaching of courses in English is offered in separate classes for groups of more than 10 incoming ERASMUS students/ course, while for smaller groups, the "reading method" is applied. This involves a study plan based on a textbook in English and 1-2 hours/ week face to face contact or by teleconference of the students with the teaching staff for monitoring studying progress and providing additional support, solve questions and inquires related to the course.

The grading system is on a 0-10 scale. The minimum passing grade is 5. When a course is accompanying by laboratory training, successful completion of all the experiments is also required. The final grade is determined according to factors, which vary from laboratory to laboratory, based on the exam grade as well as on laboratory performance. Exams are offered to the students at the end of each semester. Students who fail in these exams can take an additional exam before the beginning of the autumn semester of each year. With respect to the ECTS grading system the grades ≤ 3 correspond to the ECTS grade F and the grade 4 corresponds to the ECTS grade FX. The passing grades have the following correspondence to the ECTS grading system 5 or 5.5 $\Leftrightarrow$ E, 6 or 6.5 $\Leftrightarrow$ D, 7 or 7.5 $\Leftrightarrow$ C, 8 or 8.5 $\Leftrightarrow$ B, and 9 to 10 $\Leftrightarrow$ A.

During the final year of studies, students are optionally assigned a research project under the supervision of a member of the academic staff and are required to write a Diploma Thesis on it. The duration of the Diploma Thesis project is at least two semesters. The Thesis is successfully completed after been presented and graded by the supervisor.

A student is considered to have completed his/her studies in the Department when he/she has passed successfully courses corresponding to a minimum of 240 ECTS, according to the current EU and National Legislation.

The number of Greek credits that are assigned to each course is dictated by a regulation of the Greek Law for Higher Education (1268/82) which states that one Educational Unit corresponds to 1 hr lecture per week per semester whereas for the rest of educational work (e. g. seminars and

laboratories) one credit corresponds to 1-3 hr per week per semester. The ECTS system is based on 30 credits for each semester.

Further details are found in the web site of the Department http://**www.matersci.upatras.gr**

UNDERGRADUATE CURRICULUM

1st SEMESTER

Course Code	Course Title	Weekly Teaching Hours	Weekly Practice Hours	ECTS	Prerequisite Courses
MAS_111	Introduction to Materials Science	4	0	5	None
MAS_112	Applied Mathematics I	4	0	5	None
MAS_113	Informatics I	2	4	6	None
MAS_114	Physics I	3	0	5	None
MAS_115	Laboratory I of Physics	0	2	3	None
MAS_116	Chemistry I	4	0	6	None
Total ECTS				**30**	

2nd SEMESTER

Course Code	Course Title	Weekly Teaching Hours	Weekly Practice Hours	ECTS	Prerequisite Courses
MAS_121	Materials Science I	3	0	5	None
MAS_122	Laboratory I of Materials Science	0	2	3	None
MAS_123	Applied Mathematics II	4	0	5	None
MAS_124	Informatics II	3	1	5	None
MAS_125	Physics II	3	0	4	None
MAS_126	Laboratory II of Physics	0	2	3	None
MAS_127	Chemistry II	3	2	5	None
Total ECTS				**30**	

3st SEMESTER

Course Code	Course Title	Weekly Teaching Hours	Weekly Practice Hours	ECTS	Prerequisite Courses
MAS_231	Cellular Biology I	3	0	4	None
MAS_232	Materials Science II	4	0	6	None
MAS_233	Laboratory of Materials Science II	0	2	3	None
MAS_234	Applied Mathematics III	4	0	5	None
MAS_235	Physics III	3	0	5	None
MAS_236	Laboratory III of Physics	0	2	3	None
MAS_237	Physical Chemistry I	3	0	4	None
Total ECTS				**30**	

4th SEMESTER

Course Code	Course Title	Weekly Teaching Hours	Weekly Practice Hours	ECTS	Prerequisite Courses
MAS_241	Cellular Biology II	3	0	3	None
MAS_242	Biology Laboratory	0	2	2	None
MAS_243	Materials Science III	4	0	6	None
MAS_244	Laboratory III of Materials Science	0	2	3	None
MAS_245	Applied Mathematics IV	3	0	3	None
MAS_246	Probability Theory and Stochastic Processes	3	0	3	None
MAS_247	Physics IV	3	0	4	None
MAS_248	Laboratory IV of Physics	0	2	2	None
MAS_249	Special Topics in Mechanics	3	0	4	None
Total ECTS				**30**	

5th SEMESTER

Course Code	Course Title	Weekly Teaching Hours	Weekly Practice Hours	ECTS	Prerequisite Courses
MAS_351	Materials Science IV	4	0	6	None
MAS_352	Laboratory IV of Materials Science	0	2	3	None
MAS_353	Physical Chemistry II	3	0	4	None
MAS_354	Physical Chemistry Laboratory	0	2	2	None
MAS_355	Introduction to Quantum Mechanics	3	0	3	None
MAS_356	Chemistry III	2	2	4	None
TWO Elective Courses with 4 ECTS each				**8**	
Total ECTS				**30**	

5th Semester Offered Elective Courses					
Course Code	Course Title	Weekly Teaching Hours	Weekly Practice Hours	ECTS	Prerequisite Courses
MAS_357	Geology	2	1	4	None
MAS_358	Electronic Devices and Circuits	3	0	4	Physics III, Laboratory III of Physics
MAS_359	Informatics III	1	2	4	Informatics I and II
MAS_3511	Structural Materials	2	1	4	Materials Science I-III, Special Topics in Mechanics, Applied Mathematics IV
MAS_3512	Materials for Renewable Energy	3	0	4	Materials Science I, II

MAS_3513	Introduction to Economics for Engineers and Scientists	3	0	4	None
MAS_3514	Introduction to Business Administration and Organization for Engineers and Scientists	3	0	4	None
MAS_3515	Porous Materials	3	0	4	Materials Science I
MAS_3516	Electromagnetism and Materials	3	0	4	Applied Mathematics II, Physics II
MAS_3517	Industrial Plastics	2	1	4	Materials Science I, II, and III

6th SEMESTER

Course Code	Course Title	Weekly Teaching Hours	Weekly Practice Hours	ECTS	Prerequisite Courses
MAS_361	Materials Science V	4	0	4	None
MAS_362	Laboratory V of Materials Science	0	2	4	None
MAS_363	Statistical Mechanics	3	0	4	None
MAS_364	Elements of Molecular Physics and Quantum Chemistry	3	0	4	None
THREE Elective Courses with 4 ECTS each				**12**	
Total ECTS				**30**	

6th Semester Offered Elective Courses					
Course Code	Course Title	Weekly Teaching Hours	Weekly Practice Hours	ECTS	Prerequisite Courses
MAS_365	English Language and Terminology for Materials Science	3	0	4	Good knowledge of English
MAS_366	Science and Technology of Liquid Crystalline Materials	2	1	4	Materials Science I, Laboratory I of Materials Science, Physics III, Laboratories II & III of Physics
MAS_367	Study of Materials Structure with Scattering Techniques	2	1	4	Materials Science I, Physics IV
MAS_368	Informatics IV	2	1	4	Informatics I and II

Course Code	Course Title	Weekly Teaching Hours	Weekly Practice Hours	ECTS	Prerequisite Courses
MAS_369	Physics Education	3	0	4	Three of the following: Chemistry I, II, Physics I, II
MAS_3613	Materials for Catalytic Processes	3	0	4	Physical Chemistry I
MAS_3614	Chemistry of Advanced Materials	2	1	4	Chemistry I and II
MAS_3615	Modeling of Biological Systems	3	0	4	Cell Biology I-II, Applied Mathematics I – IV

7th SEMESTER

Course Code	Course Title	Weekly Teaching Hours	Weekly Practice Hours	ECTS	Prerequisite Courses
MAS_471	Materials Science VI	4	0	6	None
MAS_472	Laboratory VI of Materials Science	0	2	4	None
One of the three options is selected: **A)** Four elective courses with 5 ECTS each (20 ECTS in total). **B)** Three elective courses with 5 ECTS each (15 ECTS in total) and Scientific Review (5 ECTS). **C)** For students who have completed the regular years of study, if the Scientific Review has been selected in the spring semester then there is the possibility for two elective courses with 5 ECTS each (10 ECTS in total) and Diploma Thesis with 10 ECTS also.				10	
Total ECTS				**30**	

7th SemesterOffered Election Courses					
Course Code	**Course Title**	**Weekly Teaching Hours**	**Weekly Practice Hours**	**ECTS**	**Prerequisite Courses**
MAS_474	Computational Materials Science	2	1	5	Informatics I, II and IV, and Applied Mathematics IV
MAS_475	Topics in Industrial and Technological Applications of Materials I	2	1	5	Materials Science I, II and III
MAS_476	Optical and Optoelectronic Materials	3	0	5	Physics II, Materials Science II
MAS_477	Magnetic Materials	3	0	5	Materials Science I & II
MAS_479	Composite Materials	2	1	5	Materials Science III
MAS_4710	Photonics	3	0	5	Materials Science I & II, Physics IV

MAS_4711	Industrial Metals and Alloys	2	1	5	Materials Science I & II
MAS_4712	Introduction to Group theory and its application to Materials Science	3	0	5	Applied Mathematics I & II
MAS_4713	Materials and the Environment	2	1	5	Materials Science I
MAS_4714	Electronic Structure of Materials	2	1	5	Introduction to Quantum mechanics
MAS_4715	Applied Quantum Mechanics	3	0	5	Introduction to Quantum mechanics
MAS_473	Scientific Review	-	-	5	Student should have gathered 96 ECTS
MAS_481	Diploma Thesis	-	-	10	Scientific Review and the accordance of the supervisor
MAS_491	Industrial Training	-	-	5	Student should have gathered 96 ECTS
MAS_492	Training through the Erasmus Mobility Program	-	-	5	Student should have gathered 96 ECTS

8th SEMESTER

Course Title	Weekly Teaching Hours	Weekly Practice Hours	ECTS	Prerequisite Courses
One of the three options is selected: **A)** Six elective courses with 5 ECTS each (30 ECTS in total) **B)** Five elective courses with 5 ECTS each (25 ECTS in total) and Scientific Review (5 ECTS) **C)** Four elective courses with 5 ECTS each (20 ECTS in total) and Diploma Thesis with 10 ECTS.			30	
Total ECTS			**30**	

8th Semester Offered Elective Courses					
Course Code	Course Title	Weekly Teaching Hours	Weekly Practice Hours	ECTS	Prerequisite Courses
MAS_482	Surface Science-Thin Films	2	1	5	Materials Science I, II, Physical Chemistry I, Laboratory of Physical Chemistry
MAS_483	Smart Materials	2	1	5	Materials Science I, Physics III, Laboratory III of Physics

MAS_484	Semiconductor Materials and Devices	2	1	5	Materials Science V, Introduction to Quantum Mechanics
MAS_485	Topics in Industrial and Technological Applications of Materials II	2	1	5	Materials Science I, II and III
MAS_486	Ceramics and Glasses	2	1	5	Chemistry I, Materials Science II, Physical Chemistry I
MAS_487	Advanced Biomaterials	2	1	5	Materials Science IV, Cell Biology I, II.
MAS_488	Applications of Optoelectronics	1	2	5	Materials Science II, Physics IV
MAS_489	Introduction to Materials and Processes of Quantum Electronics	3	0	5	Introduction to Quantum Mechanics
MAS_4811	Molecular Nanomaterials	2	1	5	Physics IV, Materials Science V
MAS_4812	Microtechnology and nanotechnology	3	0	5	Materials Science I & II, Physics IV
MAS_4813	History and Philosophy of Natural Sciences	3	0	5	None
MAS_4814	Amorphous Alloys and Nanostructured Materials	2	1	5	Materials Science I-III, Physics I-III
MAS_473	Scientific Review	-	-	5	Student should have gathered 96 ECTS
MAS_481	Diploma Thesis	-	-	10	Scientific Review and the accordance of the supervisor
MAS_491	Industrial Training	-	-	5	Student should have gathered 96 ECTS
MAS_492	Training through the Erasmus Mobility Program	-	-	5	Student should have gathered 96 ECTS

SYLLABUS – COMPULSORY COURSES

<u>**First Semester**</u>

MAS_111 Introduction to Materials Science

1. FROM MACROCOSMOS TO THE MICROCOSMOS: The universe and galaxies. The sun and planetary system. The materials and dimensions in the macrocosms. The radiation of the sun, source of energy and life. An artificial satellite is seen with the telescope of the Earth from space. The dimensions of the objects of everyday life. The atmosphere, the gas, the molecules and atoms. The seas and liquid matter. The land, the mountains, the solid materials. An optical microscope analyses a natural rock. The electron microscope sees micro-cosmos. Images from electron microscope show the atomic structure. The dimensions of the microcosm and the structure of matter.

2. LIFE, THE MAN AND THE FIRST TOOLS: Life on Earth. Oxygen, radiation, cells, living organisms in the natural environment. Matter, energy and life. The man in the prehistoric period. Evolving from the Stone Age to the Iron Age. The first materials made and/or used by man. Stones and animal bones. Radioactivity. Structure and physical properties of earth materials. Mechanical properties and the first tools in the service of man.

3. MATERIALS AND TECHNOLOGY IN ANCIENT

Materials and the development of early civilizations. Physical properties of materials. Production and processing of materials in classical antiquity. Building materials and their properties. The stone, marble, wood, lead, copper and iron in the microscope: properties and structure. Casting and hardening of metals. The clay, ceramics and glasses in antiquity: structure and properties. The production and dyeing with nanomaterials. The plasmonic ancient materials in a spectrophotometer and the electron microscope. Tools and early machines. Levers, thermal properties, material strength. Treatment of materials from the Roman period and the Byzantine Empire in the Middle Ages. The Renaissance's as the beginning of modern science and technology materials. Propelled ground and flying machines. Computational machines.

4. THE INDUSTRIAL REVOLUTION - DEVELOPMENT METALLURGY

The industrial revolution. The metals and their properties. Metallurgy, alloys, molding and shaping of metals. The razor's edge as seen in electron microscopy. The metallic structure and properties of industrial metals. The evolution of mechanics and thermodynamics. Engines and thermal cycles. Materials and industrial technologies. From the train in micromechanics of watchmaking: Compare size, strength and techniques. Technological materials production and related industrial products. From the first train to modern cars and airplanes. The social and economic impact of the industrial revolution.

5. THE REVOLUTION OF MATERIALS AND TECHNOLOGY in THE 20TH CENTURY

Electric and magnetic materials, electrical machines and power generation. Quantum properties and structure of materials: atoms, molecules and solids. The atom Bohr, the uncertainty principle of Heisenberg's equation and Schrödinger. The photon in the "service" of materials. Spectroscopic analysis. Crystallinity and X-ray diffraction. Chemical composition of materials. The revolution of polymers. Physical and chemical properties of polymers. Biomolecular materials and biomaterials, properties and applications in medicine. Examples of composite materials from nature and from aerospace technology. The need for automated mathematics and communications. From the Antikythera mechanism to modern electronic supercomputers. The revolution in microelectronics. Electrical and optical properties of materials. Semiconducting materials, energy bands, electronic and optical properties. From transistors to electronic integration in the ultra-large scale (ULSI). Superconductors and high technology electromagnetic fields for MRI, energy production and ultra-fast trains.

6. THE 21st CENTURY OF INFORMATION AND NANOTECHNOLOGY

Materials that produce and manipulate light at the service of man. Lasers: from heavy shipbuilding industry to nano-materials processing and bio-medicine. Optical materials for energy production and information technologies. Photovoltaic energy production. Optical fibers and optical telecommunications: the Web, product materials technology. Nanomaterials and unprecedented properties of nano structured materials. Plasmons and quantum dots. Electronic and photonic properties of materials in the nanocosmos. Nanotechnology, methods, new products in the service of man: manufacturing, communications, health. The future technological and natural environment.

MAS_112 Applied Mathematics I

Functions of one variable: limit, continuity, inverse functions. Exponential, logarithmic and hyperbolic functions. Inverse trigonometric and hyperbolic functions. Differentiation of one variable functions: methods of differentiation and applications, differentials. Implicit differentiation. Functions of several variables: Limit continuity, partial derivatives, and differentials. Integration of one variable functions: methods of integration and applications. Improper integrals. First order differential equations (separable equations). Infinite series-Convergence of an infinite series. Differentiation and integration of an infinite series. Taylor series, power series. Complex numbers. Vectors. Coordinate systems. Dot and cross products. Lines and planes. Conic sections. Crammer method for the solution of linear systems of equations.

MAS_113 Informatics I

Introduction. Basic terminology. Historical overview of computing systems. The binary system. Basic concepts of Boolean algebra.
Hardware and software. Computer architecture. Central Processing Unit. Main (RAM) and cache memory. Input/Output devices. Peripheral devices. Operating System and its role. CPU Control. Memory management. File management. Applications software.
The Unix environment: Getting started, basic commands, file management, the vi editor.
Communications and Networks. Media and ways of information transmission. Network types. Functioning and communication protocols of Internet. Finding information and distributing it (electronic mail, world wide web, file transfer protocol, talk and teleconference).
Special topics. Telematics and its services. Neuronic networks. Artificial intelligence. Multimedia. Programming. Algorithms and logical diagrams.
FORTRAN90.Syntax, input-output commands, decision structures, loop structures, handling of multidimensional variables, subprograms, basic programming techniques. Practice in designing and implementing simple algorithms.

Laboratory:
Acquaintance with Microsoft Windows environment. Manipulation of files with the MS Windows Explorer, execution of simple programs, finding files or folders, controlling peripheral devices.
The MS Word processor. The spreadsheet MS Excel. MicroCal Origin for creating graphs.
Finding information and distributing it in the Internet. www, e-mail, telnet, ftp.
Acquaintance with Unix environment. File management, basic commands, the vi editor, the X-Windows environment.
The MS Fortran PowerStation environment. Development and execution of simple programs.
Flow control commands.
Using arrays and functions.
Writing and reading files.

MAS_114 Physics I

Vectors; 1D and 3D kinematics; Circular Motion; Newton's laws; Friction; Work; Energy: Potential and Kinetic Energy; Work-Energy Theorem; Work and Energy with Varying Forces; Impulse; Momentum; Dynamics of Circular Motion; Moment of Inertia; Angular Momentum; Torque; Rigid body dynamics; Elasticity; Fluid Mechanics;

MAS_115 Laboratory I of Physics

Measurements – Error Analysis. Analysis of the experimental data – Graphics.
Density of materials – Usage of Vernier caliper and Micrometer.
Determination of torsion modulus of various metallic bars.
Torsional vibrations and Moment of inertia.
Viscosity measurement with the falling-ball viscometer.
Determination of the surface tension of liquids.
Elastic and plastic deformation – Determination of the elastic modulus.

Mechanical conservation of energy – Maxwell disk.

MAS_116 Chemistry I

Atoms, molecules and ions: Atomic and molecular structure. Quantum theory of atom, quantum numbers and atomic orbitals. Periodic table and properties. Ionic and covalent bonding and molecular geometry. Solutions, acids, bases, pH, salts, stoichiometric calculations. Chemical reactions and equilibrium, Le Chatelier Principle. Rate of reactions. Redox reactions. State of matter and solutions. Chemistry of main group elements, transition metals and complexes.

Second Semester

MAS_121 Materials Science I

Introduction. Historical perspective of materials. Why Study Materials Science. Importance of materials for economy, technology and society. Classification of materials. Crystalline, quasi-crystalline and amorphous materials.
Atomic and Molecular Structure. Chemical bonds.
Structure of Crystalline Solids. Crystal structures. Crystal systems. Crystallographic lattices of Bravais. Crystallographic coordinates directions and planes. Miller indices. Amorphous materials. Anisotropy. X-Ray Diffraction: Determination of Crystal structures.
Imperfections in Solids. Point defects. Vacancies and Self-Interstitials. Impurities in Solids. Solid Solutions. Miscellaneous imperfections. Dislocations-Linear Defects. Interfacial Defects. Bulk or Volume defects.grain boundaries. Twin boundaries. Optical and electron microscopy.
Diffusion. Diffusion Mechanisms. Steady and Nonsteady-State diffusion. Factors that influence diffusion. Other diffusion paths.
Mechanical Properties of Metals. Concepts of Stress and Strain. Elastic deformation. Stress-Strain Behavior. Elastic properties of materials. Anelasticity. Plastic deformation. Tensile Properties. Compressive, Shear, and Torsional deformation. Elastic recovery during plastic deformation. Hardness. Variability of Materials Properties. Design/Safety Factors.
Dislocations and Strengthening Mechanisms. Dislocations and characteristics of dislocations. Slip systems. Plastic deformation of Polycrystalline materials. Deformation by Twinning. Mechanisms of strengthening in metals. Recovery, recrystallization and grain growth.
Failure. Fracture. Ductile and Brittle fracture. Fatigue. Cyclic Stresses. The S-N Curve. Crack initiation and propagation. Environmental effects. Creep. Stress and temperature effects.

MAS_122 Laboratory I of Materials Science

Scanning probe microscopy
Morphology of crystals/symmetry
Synthesis of materials: preparation and characterization of single crystals.
Optical microscopy for image magnification.
Preparation of metallic samples for metallographic observation.
X ray diffraction.
Determination of materials hardness.
Mechanical testing of materials: Metal tensile strength.

MAS_123 Applied Mathematics II

Contour equations; Surface equations; Scalar and Vector Fields; Directional Derivative.
Many Variables Functions: Taylor expansion; Maximum, minimum and saddle points; Lagrange Multipliers; Integrals in two and three dimensions; Coordinate transformation; Jacobian Matrix.
Matrix Algebra; Inversion of matrices; Linear equations; Vector spaces; Linear independence and bases; Eigenvalues and eigenvectors; Diagonalization of matrices.

MAS_124 Informatics II

Introduction to numerical analysis. Number systems, errors, computational methods for error estimation.
 Solving non-linear equations and non-linear sets of equations with the Bisections, Newton-Raphson and Secant methods.
Interpolation and extrapolation. Linear and polynomial interpolations.
Integration. Trapezoidal and Simpson complex rules. Romberg method.
Solving linear sets of equations with direct (Gauss elimination) and recursive methods.
Solving differential equations. Euler and Runge-Kutta methods.

 Laboratory:
   i. Solving non-linear equations.
  ii. Interpolation, extrapolation and integration.
 iii. Solving of linear systems of equations
  iv. Differential equations.

MAS_125 Physics II

THERMODYNAMICS. Temperature, ideal gas, heat, heat capacity and specific heat. Thermal expansion. First law of thermodynamics. Introduction to kinetic theory of gases. Laws of ideal gases-PVT variations. Equation of state. Second law of thermodynamics. Thermal machines. Entropy. Heat conduction. OSCILLATIONS. Fundamental concepts, energy considerations in the simple harmonic motion, equations of the simple harmonic motion. The simple pendulum, the physical pendulum. Damped oscillations, forced oscillations and resonance. Types of waves, travelling waves, one-dimensional waves, superposition and interference of waves. Velocity of waves in strings, reflection and transmission of waves. Harmonic waves, the energy of harmonic waves in strings. The linear equation of a wave. Velocity of the sound waves, harmonic sound waves, energy and intensity of the harmonic sound waves. Spherical and planar waves. The Doppler effect. Superposition and interference of harmonic waves. Standing waves, standing waves

in strings fixed at ends, resonance, standing waves in air columns, standing waves in rods and membranes. Beats, complex waves. Wave polarization. Characteristic parameters of a wave. Interference and diffraction of waves. Physical waves.

MAS_126 Laboratory II of Physics

Thermal expansion: Measurement of the linear expansion coefficient of various metals.
Determination of heat capacity of calorimeterand heat of melting ice.
Measurement of heat of vaporization by means of diagram $\theta = f(t)$.
Electrical equivalent of heat.
Simple harmonic ooscillator. Mass-spring oscillation.
Calculation of the acceleration of gravity with the natural pendulum.
Study of stationary waves in chord.
Study of a beat.
Standing sound waves and determination of the speed of sound in the air
Sound waves diffraction.

MAS_127 Chemistry II

Introduction, Hydrocarbons, alkanes, cycloalcanes, alkenes, alkynes. Names and isomers. Physical properties and reactions of hydrocarbons. Alkylhalides. Reaction mechanisms. Nucleophilic substitution, elimination. Oxygen containing organic compounds: alcohols, aldehydes, ketones, carboxylic acids, and derivatives. Properties and reactions of oxygen containing organic compounds. Nucleophilic substitution to carbonyl bond. Spectroscopy of organic compounds. Nitrogen containing organic compounds. Aromatic compounds. Polarity and inductive effect. Electrophilic aromatic substitutions. Organic polymers. Biomolecules: proteins, carbohydrates, nucleic acids, lipids.

Part A (4 laboratory experiments)
1. Hygiene and safety in the lab- Basic equipments and use.
2. Preparation and dilution of solutions.
3. Separation of mixtures – solids from liquids – preparation of insoluble salt
4. Isolation of natural products (caffeine) – extraction
5. Coagulation of proteins – Diurea test for protein detection

Part B (2 laboratory experiments)
1. Preparation of K-Cr alum
2. Reaction rate
3. Preparation of double salt Nickel ammonium

Part C. (2 laboratory experiments)
1. Esterification (aspirin preparation)
2. Esterification (wintergreen oil)
3. Amide bond formation (acetanilide)
4. Saponification

Third Semester

MAS_231 Cellular Biology I

Introduction to the cell.
Prokaryotes, eukaryotes and viruses

The chemical components of the cell.
Macromolecules: structure, shape and information.
Techniques used to study the cells (microscopy, isolation of cells and growth in culture, fractionation and analysis of their components, tracing and assaying molecules inside the cells).
Membrane structure.
Membrane transport of small molecules and the ionic basis of membrane excitability.
Nerve cells and the transmission of signals along them.
Intracellular compartments and protein sorting.
Vesicular transport in the secretory and endocytic pathways.
The mitochondrion: structure/function
The cytoskeleton.
Cell-cell interactions. Cell junctions, cell adhesion, and the extracellular matrix.
Tissue formation and maintenance.

MAS_232 Materials Science II

Phase Diagrams. Solubility limit, Phases, Microstructures. Phase Equilibria. Equilibrium Phase Diagrams. Binary isomorphous and eutectic systems. Eutectoid and Peritectic reactions. The Gibbs Phase rule. The Iron-Carbon system. The Iron-Iron Carbide (Fe-Fe3C) phase diagram. Development of Microstructures in Iron-Carbon alloys. The influence of other alloying elements.

Phase Transformation in Metals and Development of Microstructure. Phase transformations. Microstructural and property changes in iron-carbon alloys. Isothermal transformation diagrams. Continuous cooling transformation diagrams. Mechanical behavior of iron-carbon alloys. Tempered martensite.

Thermal Processing of Metal Alloys. Annealing processes. Heat treatment of steels. Hardenability and Influence of quenching medium, specimen size and geometry. Precipitation hardening. Heat treatments and mechanism of hardening.

Metal Alloys. Fabrication of metals. Ferrous alloys. Nonferrous alloys. Copper, Aluminum, Magnisium, Titanium alloys. Refractory alloys. Superalloys. Noble metals.

Ceramic Materials. Crystal structure and properties of ceramics. Silicate ceramics. Carbon (diamond, graphite, fullerenes). Imperfections in ceramics. Ceramic phase diagrams. Mechanical properties. Brittle fracture of ceramics. Stress-Strain behavior. Mechanisms of plastic deformation.

Applications and processing of Ceramics. Glasses. Properties, forming and heat treatment of glasses. Glass-ceramics. Clay products. The characteristics, compositions and fabrication techniques of clay products. Drying and firing.

Refractories. Fireclay and silica refractories. Special refractories. Other applications and Processing methods. Abrasives. Powder pressing. Tape casting. Cements. Advanced ceramics.

MAS_233 Laboratory II of Materials Science

Determination of the Young's modulus of metals via the bending test.
Determination of elastic moduli of metals and ceramics via the ultrasonic method.
Thermal Processing of materials.
Phase diagrams of metals and alloys.
Jominy test.

Preparation of titania ceramic via the sol-gel method.

MAS_234 Applied Mathematics III

Functions of a complex variable. Differentiation and integration of functions of a complex variable. Cauchy's integral theorem. Laurent expansion. Calculus of residues.

Homogeneous and inhomogeneous ordinary differential equations. First order ordinary differential equations and methods of solution. N-th order ordinary differential equations with constant coefficients and methods of solution. Laplace transform and its application to the solution of ordinary differential equations. Methods of solution of systems of differential equations.

Series solutions of ordinary differential equations-Frobenius' method. Bessel functions. Legendre polynomials, orthogonality and expansion of functions in series of Legendre polynomials.

Periodic functions, Fourier series, sine Fourier series, cosine Fourier series, complex representation of Fourier series, Parseval's identity. Orthogonal and orthonormal functions-Kronecker delta. Applications of Fourier series.

MAS_235 Physics III

Electric charge and electric field. Coulomb's law and Gauss' Law. Electric potential. Capacity and dielectrics.

Direct current, resistor and electromotive force. Ohm's law. DC circuits. Kirchoff's laws.

Magnetic field and magnetic forces. Magnetic field sources. Magnetic flux. Biot-Savart's law. Ampere's law. Electromagnetic induction. Self-induction and mutual inductance.

Alternating current. Transformers. Electromagnetic oscillations. Thomson's circuits. Maxwell's equations. Electromagnetic waves.

Nature and propagation of light. Geometric optics. Reflection and refraction of light. Mirrors and lenses. Dispersion of white light by prisms. The wave nature of light. Interference, diffraction by narrow slits and gratings, polarization of light.

MAS_236 Laboratory III of Physics

Electrostatic fields and equal-potential surfaces.
Ohm's Law – determination of metals resistivity.
The Wheatstone bridge.
RL circuit - operating principles of oscilloscope.
RC circuit
Determination of the dielectric constant of materials.
Biot-Savart's law- magnetic field of circular coil.

MAS_237 Physical Chemistry I

Thermodynamic Equilibrium. Ideal gas laws. Molecular interactions and real gases.

The first law of thermodynamics. Work and energy. Enthalpy. Adiabatic changes. Thermochemistry. Standard enthalpy changes. Formation enthalpies. Reaction enthalpies and their temperature dependence. State functions. The relation between CV and Cp.

The second law of thermodynamics. Spontaneous changes. Entropy and entropic changes. The third law of thermodynamics. Helmholtz and Gibbs free energies.

Combining the first and second laws of thermodynamics. Properties of the internal energy and of the Gibbs free energy. The chemical potential.

Phase transformations of pure substances. Phase diagrams. Phase stability and phase boundaries. The thermodynamic criterion of equilibrium. Ehrenfest's classification of phase transformation. The liquid surface. Surface tension.

Phase transformations in mixtures. Thermodynamic description of mixtures. Partial molar quantities. Solutions. Colligative properties. The phase rule.

Fourth Semester

MAS_241 Cellular Biology II

Nucleus. Chromosomal organization.
Molecular genetics: transcription, translation.
Recombinant DNA technology, genetic engineering.
Cell division. Regulation of cell cycle.
Cell death and apoptosis.
Cancer. Differentiated cells and tissue organization.
The cellular and molecular basis of immune response. Immune response to tissue injury and implants.

MAS_242 Biology Laboratory

Introduction to Microscopy
Studying Cells using Microscopy
Mitosis
Blood: cell types and cell counting
Histology
UV-Vis spectroscopy, Hemoglobin
Immobilization of proteins on materials

MAS_243 Materials Science III

Polymers: hydrocarbon molecules and macromolecules. Chemistry of polymers. Polymer crystallinity. Classification of polymers. Mechanisms of polymerization. Polymerization processes. Characteristics of polymers (Molecular weight, degree of polymerization, polydispersity index). Structure of polymers, chemical composition, tacticity, orientation, crystallinity. Amorphous and crystalline polymers. Determination of polymer crystallinity. Melt and glass transition. Treatment of polymers. Determination of molecular weight. Mechanical properties, Hooke's low, Newton's low of viscosity. Viscoelasticity, stress-strain curves, Young's modulus, fracture point, elastic limit, creeping and relaxation of strain, models of viscoelastic behaviour. Hardness, impact resistance. Thermal properties. Chemical properties. Permeability, Fick's law of diffusion. Common polymers. Composites, principle of combined action, components, fibers. Orientation of fibers. Corrosion of materials, protection from corrosion, polymer degradation.

MAS_244 Laboratory III of Materials Science

Polymer synthesis through radical and condensation polymerization.
Viscoelastic behavior and tensile strength experiments on polymers.
Effects of environmental aspects and of solvents on the mechanical properties of polymers.
Differential Scanning Calorimetry (DSC) and Dynamic Mechanical Analysis (DMA) for polymer characterization.

MAS_245 Applied Mathematics IV

Integral Fourier Transforms, δ-Dirac, Orthonormality, applications. Partial differential equations, Laplace equations, heat transfer equations. Variable separation method. Sturm-Liouville theory and applications. Green's functions and applications.

MAS_246 Probability Theory and Stochastic Processes

Probability and Relative frequency. Basic concepts and definitions. The Axioms of Probability. Conditional Probability. Statistical Independence.
Discrete and Continuous Random Variables. Probability and Probability Distribution Functions. Coefficients of Distributions. Generating and Characteristic Functions.
Important Probability Distributions. Discrete: Bernoulli, Binomial, Poisson, Geometrical. Continuous: Uniform, Normal, Gamma, Exponential, X_2, t, F.
Some Limit Theorems. The Central Limit Theorem.
Statistics. Sampling distributions. Random sample and sampling. The Basic theorem of Statistics. Estimators. Estimation methods. Point Estimation. Criteria for selecting an estimator. Testing Hypothesis. Confidence testing with X_2 criterion. Correlation and Regression Analysis. Simple and multiple linear regression. Analysis of Variance.

MAS_247 Physics IV

Classical theory of light. Huygens principle, refractive index, classical dispersion model, Snell's law, geometrical propagation, Gauss and lens maker's formuli, image formation. Interference and diffraction, optical elements and system: microscope and telecope, Michelson and Young interferometers, diffraction gratings.

Black bodey radiation, Planck's Law, foundations of quantum theory, energy levels, photoelectric effect and the concept of photon, wave-matter and DeBroglie principle electron diffraction, Heisenberg's unceratainty principe, wavefuctions, quantum wells, tunneling effects, Atomic model of Bohr, Hydrogen atom, quantum numbers, Pauli principle and periodic system. Selction rules, Molecular structure. Structure of solids.

Atomic transitions, spectram broadening, coherence of light, spontaneous and stimulated emission. Fluorescence, laser radiation. Laser amplifiers and oscillators.

Special topics of nuclear physics and special relativity theory.

MAS_248 Laboratory IV of Physics

Radiation sources
Lasser radiation
Photoelectric effect
Optical interference and diffraction
Electron diffraction
Scattering and fluorescence
Semicondutor devices
Nuclear radiation

MAS_249 Special Topics in Mechanics

Theory of oscillators and coupled oscillators. Oscillations in two dimensions. Kinetics in one dimension, equilibrium points, small oscillations.

Normal modes of oscillator systems.
Lagrange and Hamilton equations of motion. Movement of two bodies in a central field. Tensors theory. Elastic properties of materials and elastic constants. Vector of tension and tensor of deformations. Theory of linear elasticity. General law of Hooke. Tensor of elasticity. Beam related problems.

Fifth Semester

MAS_351 Materials Science IV

Introduction. Historical background. Biological materials. Collagen. Clinical applications of biomaterials. Dental biomaterials. Tooth: Structure, composition, properties. Dental implants. Titanium and its alloys. Surface treatment of titanium. Dental amalgams. Dental cements. Non-metallic dental biomaterials, resins. Biomaterials in orthopaedics. Bones: Structure, properties. Bone injuries, fractures. Hip and knee arthroplasty. PMMA bone cement. Ultrahigh density polyethylene. Materials in hip and knee arthroplasty. Biomaterials as bone defect substitutes. Calcium phosphate bone cements, bioactive glasses, ceramics. Biomaterials in cardiology. Angioplasty, coronary stents. Applications of biomaterials in urology. Urological catheters. Problems associated with the use of biomaterials in urology. Synthetic polymers with specific applications as biomaterials, silicones. Applications of biomaterials in dermatology. Histological structure of skin. Skin burn injuries, biomaterials in burn treatment. Transdermal drug delivery. Biodegradable polymers: applications. Hydrogels: Structure, properties, applications. Corrosion of metallic biomaterials. Biomedical nanotechnology. Biomimetics. Surface properties of biomaterials. Interactions between proteins and biomaterials. Interactions between cells and biomaterials.

Prerequisite knowledge: Cell Biology II, Materials Science II

MAS_352 Laboratory IV of Materials Science

1. Preparation of biorelevant media (PBS, SBF, SGF, SIF)
2. Characterization of encrustations formed on urinary biomaterials using spectroscopic techniques.
3. Preparation of calcium phosphate compound with applications in biomaterials.
4. Synthesis of SiO_2-CaO bioactive glasses by the sol-gel method.
5. Synthesis of biodegradable polylactic acid nanoparticles
6. Synthesis and properties of Hydrogels

MAS_353 Physical Chemistry II

Equilibrium electrochemistry, Thermodynamics properties of ions in solutions, Ionic activities, Electrochemical cells, Half reactions and electrodes. Redox potentials. pH and pK. Dynamical Electrochemistry. Electrode phenomena. Electrical Double Layer. Charge transfer rate. Electron transfer. Electrochemical processes on solid surfaces. Growth and structure of surfaces. Adsorption. Physisorption and Chemisorption. Catalytic action on surfaces. Adsorption and catalysis. Corrosion and material degradation. Corrosion electrochemistry. Corrosion rates. Types of corrosion. Prevention of corrosion. Macromolecules and molecular aggregates. Colloids.

MAS_354 Physical Chemistry Laboratory

1. Formatino constant of complex ion
2. Study of complexes with UV-Vis spectroscopy
3. Phase diagram of 3-component
4. Refractometry
5. Chemical kinetics (ester hydrolysis in acidic environment)
6. Potentiometric titrations
    6a. redox reactions
    6b. determination of a weak acid dissociation constant
    6c. buffer solution study
    6d. zero point determination of solid metal oxides
7. Gas chromatography (Van Deemter equation)
8. Calorimetry
9. Conductivity
    9a. weak electrolyte dissociation constant
    9b. equivalent point

MAS_355 Introduction to Quantum Mechanics

General Principles: Particles/waves, Schrödinger's equation, statistical description of the wavefunction, measurable quantities and operators.
Eigenvalues, Eigenfunctions, Conservation laws, Dirac symbolism.
Applications: Particle in one two and three dimensional box; Scattering from one dimensional potentials; Tunneling effect; Harmonic oscillator; Rotation in two and three dimensions; Spherical Harmonics; Central Potentials; Hydrogen Atom.
Spin; Spin operators; Pauli matrices; Particle in a magnetic field.

MAS_356 Chemistry III

Classification of analytical methods, types of instrumental analytical methods, analytical instruments, choice of method, calibration. Signal and noise. Introduction to spectroscopic techniques. Quantitative spectroscopy. Parts of the instruments. Introduction to atomic absorption spectroscopy. Atomic absorption and emission spectrometry. X Rays Atomic spectrometry. Basic principles. Parts of the instruments. X-Rays emission or absorption spectroscopic methods. X-Ray Diffraction analysis. Introduction in molecular spectrometry of UV-Vis and application. Molecular luminescence spectrometry. Basic principles of luminescence.
Introduction to Infrared spectroscopy and applications. Raman spectroscopy and application. NMR spectroscopy. Surface study with spectroscopy and microscopy. Chromatographic analysis, high pressure liquid chromatography. Thermal analytical methods.

Exercise 1) Quantitative analysis of pyranine (UV-Vis)
Exercise 2) Flame test for the determination of metals
Exercise 3) NMR spectroscopy
Exercise 4) IR spectroscopy
Exercise 5) Chlorophyll extraction and separation with TLC
Exercise 6) High pressure liquid chromatography. Analysis of an analgesic medicine.

Sixth Semester

MAS_361 Materials Science V

Electronic and crystal structure of solids. Lattice vibrations. Phonons. Fermi statistics. Free electron gas. Energy bands. Electrical and thermal conductivity. Heat capacity. Resistivity. Hall effect. Energy bands. Bloch functions. Kronig-Penney model. Conductors. Semiconductors. Electronic structure of semiconductors. Imperfections, mechanical behavior and dislocations, formation and crystal growth, crystal melting. Order-disorder transformations.

Electronic band structures of semiconductors. Energy bands. Direct and indirect energy gap. Electrons and holes. Effective mass. Intrinsic semiconductors and doping. Carrier mobility and concentration. Extrinsic semiconductors. Majority and minority carriers. P-N junction. Schottky barrier. Negative resistance and Gunn effect. Amorphous semiconductors. Semiconductor devices: FET transistor, Zener diode, MOS and CMOS technology, integrated circuits. Microelectronics. Nanoelectronics.

Dielectric materials. Polarization, polarizability. Electric susceptibility and permeability. Local Field. Lorentz theory. Permeability's frequency dependence. Refractive index and dispersion. Propagation and absorption of electromagnetic wave. Crystal lattices and dielectric compounds. Ferroelectic and paraelectric compounds. Piezoelectric and pyroelectric effect. Electromagnetic absorption devices.

Magnetic materials. Diamagnetism. Langevin theory of diamagnetism. Paramagnetism. Quantum theory of Paramagnetism. Paramagnetism of conduction electrons. Ferromagnetism. Curie temperature. Curie-Weiss law. Temperature dependence of the saturation magnetization. Ferrimagnetism. Curie temperature and susceptibility of ferrimagnetic compounds. Ferromagnetic domains. Magnetic thin films. Magnetic information storage. Supeconductivity. Critical magnetic field. Meissner effect. Type I and II superconductor and relevant thermodynamics. BCS theory, Josephson devices, high temperature superconductors. SQUID

MAS_362 Laboratory V of Materials Science

1. Kronig-Penney model.
2. The Hall effect in semiconductors.
3. Electrical resistivity of Ge as a function of temperature. Determination of electronic energy gap of Ge.
4. Dielectric behavior of selected materials under the influence of ac field and as a function of temperature.
5. Ferromagnetic materials.
6. High T_c superconductivity.

MAS_363 Statistical Mechanics

Equilibrium thermodynamics and macro- micro states of a thermodynamic system. Molecular partition function. Translation, vibrational, rotational and electronic partition functions. Statistical ensembles. From the partition function to the free energy.
Boltzmann, Fermi-Dirac και Bose-Einsein statistics.
Exactly solvable problems of interacting systems. (Ising model, Tonk's gas, RIS model for polymers)
Introduction to the Landau theory for phase transitions. Mean field theory.
Introduction to computer simulations with Monte Carlo and Molecular Dynamics.

MAS_364 Elements of Molecular Physics and Quantum Chemistry

Approximation Methods: First order time-independent perturbation theory. Variational method. Time-dependent perturbation theory, two-level system.

Atomic Structure: Indistinguishable and identical particles. Pauli exclusion and generalized principles. The Helium atom. Many-electron atoms. The building-up principle. Periodic table.

Molecular Structure: Born-Oppenheimer approximation. Hydrogen molecular ion. Molecular orbital theory, LCAO-MO. Diatomic and polyatomic molecules. The Huckel approximation. Tight-binding model and the band theory of solids.

Molecular Symmetry: Operation and symmetry elements. Symmetry classification of molecules. Immediate consequences of symmetry.

Molecular Spectroscopy: General features. Populations, intensity, selection rules and linewidth. Vibration and Rotation Spectra of diatomic and polyatomic molecules. The Raman effect. Electronic transitions.

Electric and Magnetic Properties of Molecules: Electric properties. Permanent and induced electric dipole moments. Polarization. Magnetic properties. Magnetic susceptibility. Permanent and induced magnetic dipole moments.

Seventh Semester

MAS_471 Materials Science VI

Optical Properties of Metals and Insulators. Complex Index of Refraction. Linear Optical Properties. Reflection and Absorption Fresnel Equations. Characteristic Angles. Resonance Procedures and Drude/Lorentz Models. Damping Phenomena and Optical Resonances.

Optical Properties of metal and Semiconductors: Plasmon Resonance. Absorption in Uv-Infrared. Luminescence in Solids. Phosphorescence. Photoluminescence. Electroluminescence. Electrical and Optical Pumping.

Dielectric Optical Materials: Crystal Optics. Index of Refraction Dispersion. Dielectric Tensor. Birefringence. Photoelastic Phenomena. Non Linear Optical Susceptibility and Other Higher Order Phenomena. Electrooptic, Acoustooptic, Magnetooptic Phenomena. Photochromism. Photorefraction.

Light Sources: Laser Physics and Technology. LED and Semiconductor Laser. Thermal and Quantum Detectors. Light Interferometric and Diffractive Optical Systems: Diffraction Systems. Waveguides. Photonic Materials. Photonic Energy Gaps and dispersion relations.

Crystal Growth Techniques: Epitaxial Methods. Czochralski, CVD, MOCVD, PVE, MBE, Ion Beam and Laser methods. Lithography and Nanolithography. Device Processing.

Nanophase materials. Semiconducting Nanostructures Quantum Wells, Wires and Dots. Metallic Nanomaterials. Nanotechnology and Related Applications.

MAS_472 Laboratory VI of Materials Science

1. Optical properties of materials: glass and thin semiconductor films
2. Photovoltaic Elements
3. Emitting diode (LED) and laser diode.
4. Photoelastic phenomena and ellipsometry
5. Optical Interferometry
6. Simulation of diffraction effects

SYLLABUS ELECTIVE COURSES

Fifth Semester

MAS_357 Geology

Prerequisite Courses: None.

1. Origin of chemical elements
2. Crystallography - Mineral Chemistry
3. Physical properties of minerals
4. Magmatic Rocks
5. Sedimentary Rocks
6. Metamorphic Rocks
7. Erosion
8. Measuring the geological time -time scale
9. The structure of the Planet Earth
10. Evolution of the planet Earth
11. Earthquakes and the interior of the Planet Earth.

MAS_358 Electronic Devices and Circuits

Prerequisite Courses: Physics III, Laboratory III of Physics.

Conductors-Semiconductors. Conductivity of semiconductors. The on junction. The solid state diode-modeling and simple applications. Bipolar transistor: Operation-modeling- simple analogue amplifier-digital gates. Software for circuit analysis. Heterojunctions: Metal-semiconductor junction, CMOS technology, MOS transistor-modeling and applications Technology of integrated circuits. Integration processes.

MAS_359 Informatics III

Prerequisite Courses: Informatics I and II.

Basic commands of Mathematica. Definition of constants and matrices and basic linear algebra. Definition of functions. Plotting diagrams in two and three dimensions and contour plots. Analytical and numerical calculation of integrals. Analytical and numerical solution of nonlinear equations, linear systems of equations, ordinary differential equations and partial differential equations. Applications of the above in problems in Physics, Chemistry, Materials Science and technological problems.

MAS_3511 Structural Materials

Prerequisite Courses: Materials Science I-III, Special Topics in Mechanics, Applied Mathematics IV.

  i. The microstructure of materials.
 ii. Physical, thermal, and mechanical properties of materials.
iii. Natural stones and their products.
 iv. Hydraulic and air-hardened binders and mortars.
  v. Concrete: microstructure, constituents, strength, deformations, durability, mix design, fresh concrete.
 vi. Steel and other metals: technological and mechanical properties, corrosion.
vii. Timber: technology, microstructure, mechanical properties, durability.
viii. Ceramics: physical and mechanical characteristics of clay bricks and other products.
 ix. Masonry: mechanical behaviour, durability.

x. Polymers: basic properties, environmental effects, fiber reinforcement, cellular materials.

MAS_3512 Materials for Renewable Energy

Prerequisite Courses: Materials Science I and II.

Photovoltaic materials: Silicon based solar cells, thin films, nanostructured materials (CdTe, CIGS), organic solar cells, dye sensitized solar cells.
Wind power and related materials.
Fuel Cells
Materials for hydrogen storage: metal hydrides, carbon based materials, metal-organic-frameworks.

MAS_3513 Introduction to Economics for Engineers and Scientists

Prerequisite Courses: None

The course is a general introduction in micro and macroeconomics. In addition, some basic elements of the economics of innovation and investments analysis are included. The following sections compose the body of the course:
- The fundamental economic problem
- Consumer's Behavior
- Firms' production and costs
- Demand and Supply
- Elasticities, endogenous and exogenous shocks
- Competition and Business Strategies
- Key Macroeconomic measures
- The role of state intervention and the open economies
- Aspects of innovation and entrepreneurship
- Basic elements of investment projects evaluation.

MAS_3514 Introduction to Business Administration and Organization for Engineers and Scientists

Prerequisite Courses: None.

1. Introduction to Management
2. Planning
3. Organizing
4. Leading
5. Controlling.

MAS_3515 Porous Materials

Prerequisite Courses: Materials Science I.

1. Introduction
2. Porous materials classification
3. Natural porous materials
4. Synthetic porous materials
5. Preparation methodologies
6. Adsorption theories, Isotherms, Specific area, Size distribution
7. Characterization techniques for porous materials
8. Nitrogen porosimetry, system demonstration and familiarization
9. Mercury porosimetry
10. Microporous materials

11. Mesoporous materials
12. Macroporous materials
13. Hierarchically porous materials
14. Zeolites
15. Phyllomorphous and pillared interlayered clays
16. Silica porous materials
17. Carbon porous materials
18. Hybrid porous materials, PMOs, MOFs, COFs
19. Porous materials applications.

MAS_3516 Electromagnetism and Materials

Prerequisite Courses: Applied Mathematics II, Physics II.

Introduction to the theoretical classical electrodynamics in relation to materials:

Review of necessary mathematical tools such as, vector algebra and fields, differential and integral calculus, curvilinear coordinates, Dirac delta function. Electric field and Gauss's law, electric potential and its multipole expansion, Poisson's and Laplace's equation, conductors and the method of images, work and energy in electrostatics, magnetic vector potential. Polarization, electric displacement, linear dielectrics, magnetic field inside matter, Ampere's law in magnetized materials, magnetic fields in linear and nonlinear media. Maxwell equations in free-space and matter, electromagnetic waves in vacuum and matter, absorption and dispersion, scalar and vector potentials, gauge transformations, Coulomb and Lorenz gauge.

MAS_3517 Industrial Plastics

Prerequisite Courses: Materials Science I, II, and III.

List of procedures and production methods for the preparation of plastics and their effect on the materials design. Ingredients of plastics. Selection and characterization of commercial plastics. Mechanical treatments. Methods of machining, finishing, molding processes, extrusion processes, laminating processes and materials, reinforcing processes and materials, thermoforming, expansion processes, coating, fabrication, decoration, radiation processes. Design consideration, commercial consideration, tooling and moldmaking. Thermoplastic and thermosetting plastics.

Sixth Semester

MAS_365 English Language and Terminology for Materials Science

Prerequisite Courses: Good knowledge of English.

- Introduction to Materials Science
- Types of materials
- Properties of materials
- Polymers
- Metals-alloys
- Steel
- Ceramics
- Semi-conductors
- Nanotechnology and Materials science
- Two research articles.

MAS_366 Science and Technology of Liquid Crystalline Materials

Prerequisite Courses: Materials Science I, Laboratory I of Materials Science, Physics III, Laboratories II & III of Physics.

The various liquid crystalline phases and their molecular organization. Order parameters and phase transitions.
Electrical, optical and mechanical properties of liquid crystals. Structural defects. Characterization techniques for liquid crystals.
Ferroelectric, pyroelectric and piezoelectric Liquid crystals. Hysteresis and memory effects. Information storage systems.
Opto-electric, opto-electronic, opto-mechanical, thermo-optical and electro-mechanical applications. Liquid crystals in information technology.
Self-assembly and lyotropic phases. Macromolecular and supermolecular liquid crystals. Nano- composite soft materials. Liquid crystalline molecular organization in biology.
Laboratory training:
Polarized optical microscopy of liquid crystals and determination of phase transition temperatures Differential scanning calorimetry of liquid crystals. Determination of phase transition temperatures and entropies.
Observing phase coexistence by contact samples under a polarizing optical microscope.
Determination of the dielectric anisotropy of a liquid crystal.
Dielectric response of a nematic liquid crystal ii the frequency range 0.1 Hz- 1 MHz.
Switching of ferroelectric liquid crystals.

MAS_367 Study of Materials Structure with Scattering Techniques
Prerequisite Courses: Materials Science I, Physics IV.

Geometry of crystals. Symmetry operations. Point Groups, Herman-Maugin and Schonflies notation. Bravais Lattices. Space groups. International Tables of Crystallography. Reciprocal Lattice. Diffractometer and Synchrotron X-ray diffraction measurements. Bragg's law. Laue's Equations. Reciprocal lattice and diffraction. Brillouin zones. Scattering by an electron, atom and unit cell. Form Factor and Structure Factor. Application to Polycrystal diffraction (Lorentz, Absorption and Temperature factors). The effect of strain and crystallite size on diffraction peaks. Determination of crystal structure. Indexing patterns of cubic and non-cubic crystals. Basic principles of electron and neutron diffraction.

MAS_368 Informatics IV (Introduction to Computer Science of Materials)

Prerequisite Courses: Informatics I and II.

First principles calculations (ab initio).

A. Molecules. Molecular structures and symmetry. A short presentation of Quantum Chemistry program packages, fields of application, advantages and disadvantages. Design of molecular structures and calculation setup by means of open source software. Common calculation types: Total energy, geometry optimization, frequencies, excited states, potential energy surfaces, modeling of chemical reactions, thermochemistry. Interpretation and post-processing of results, population analysis (e.g. Mulliken, Lowdin, AIM), density of states, UV/Vis, IR and Raman spectra, visualization programs.

B. Periodic structures (solids, surfaces, 1D structures). A short presentation of program packages capable of periodic boundary conditions calculations with emphasis on their fields of application and their particular strength. Design of periodic structures and

calculation setup by means of open source software. Plane wave representation of wavefunctions and pseudopotentials. Common calculation types: Total energy, geometry optimization, cell optimization, calculation of stress and elastic properties, phonons, electronic and phononic band structure and density of states diagrams.

Introduction to Molecular Simulation

Intermolecular potentials and force fields. Principles and basic algorithms of Molecular Dynamics (MD) computer simulations. Thermosteting and MD simulations in constant temperature conditions. Post processing of MD simulation results. Practice with MD simulations of simple systems. Introduction to the Monte Carlo molecular simulations with examples from model lattice systems and magnetism.

MAS_369 Physics Education

Prerequisite Courses: Three of the following: Chemistry I, II, Physics I, II.

- The importance of understanding the Natural Sciences for every Citizen. Scientific Literacy.
- Aims and objectives of science teaching.
- Classroom management. Semiotics.
- Teaching methods (modern trends). Constructivism. Teaching aids. Course design (Lesson plan).
- Laboratory teaching. Equipment.
- Education (training) of a science teacher. Associate activities of a science teacher.
- Correlation of Science with Other Sciences (Interdisciplinarity).
- Evaluation.
- Lifelong Learning and "in service"- training.
- The situation in "the teaching of Physical Sciences" at European level.

MAS_3613 Materials for Catalytic Processes

Prerequisite Courses: Physical Chemistry I.

Introduction to Basic Concepts (Catalysis, Catalyst, Active Sites, Activity, Selectivity, Conversion, Rate).
Thermodynamics and kinetics of heterogeneous catalytic reactions.
Solid catalysts (metals, oxides, supported catalysts, monolithic catalysts).
Methods for the synthesis and characterization of solid catalysts.
Chemical adsorption-desorption on catalytic
surfaces. Basic mechanisms of heterogeneous
catalytic reactions.
Selected heterogeneous catalytic processes of environmental and energy interest.
The course includes obligatory seminars on the basics of scientific text writing, on literature search on scientific databases and oral presentation.

MAS_3614 Chemistry of Advanced Materials

Prerequisite Courses: Chemistry I, Chemistry II.

Chemical reactions. Design, preparation, control, isolation of the product, purification and characterisation.
Types of chemical reactions. Reactions in solvents (solvent, temperature, stirring, reflux), solid state reactions, surface chemistry (hydrophobic and hydrophilic surfaces), hydrothermal treatment, reactions in microwaves.
Principles of photochemistry.
Chemistry of phyllomorphus

materials.

Supermolecular chemistry (non bonding interactions, self aggregation).

Redox reactions with metals (reductions of metals and formation of nanoparticles, metal oxidation). Reactions of complexes.

Organic reactions in materials (amide bond, protection and deprotection of organic groups, estrification, reaction of epoxy group).

Laboratory practice

Preparation of inorganic salt, isolation, purification, characterization with spectroscopy and estimation of yield.

Preparation of organic compound, isolation, purification, characterization with spectroscopy and estimation of yield.

MAS_3615 Modeling of Biological Systems

Prerequisite Courses: Cell Biology I-II, Applied Mathematics I – IV.

Biomolecular reactions, Degradation, Ligand-receptor binding and cooperative binding, Michaelis- Menten kinetics.

Two-state biomolecular systems, Phosphorylation, Monod-Wyman-Changeux (MWC) model, Ion channels and its regulation.

Cytoskeletal polymerization, Equilibrium length distribution and fluctuations, Kinetics of polymerization, Dynamic instability.

Electrically charged biomolecular systems in salty solutions, Screening, Poisson-Boltzmann equation.

Diffusion in biological systems, Fluorescence recovery experiments (FRAP), Arrival of signaling molecules in cellular receptors, Bacterial chemotaxis.

Regulatory genetic networks, Promoters, mPRNA distributions, Protein translation, Genetic switches and oscillators.

Biological patterns, Morphogens, Turing patterns and Turing instability, Lateral inhibition and the Notch-Delta system.

Seventh Semester

MAS_474 Computational Materials Science

Prerequisite Courses: Informatics I, II and IV, and Applied Mathematics IV.

Fundamental Principles; Ab initio Methods; Density Functional Theory; Molecular Mechanics; Numerical methods for solving partial differential equations and boundary value problems. Numerical methods for integral equations. Applications in materials science related problems.

MAS_475 Topics in Industrial and Technological Applications of Materials I

Prerequisite Courses: Materials Science I, II and III.

The course includes a series of lectures concerning industrial and technological applications of materials. The lectures are given mainly by industry/organizations executives with high academic knowledge and expertise in a wide range of materials science applications.

MAS_476 Optical and Optoelectronic Materials

Prerequisite Courses: Physics II, Materials Science II.

Synopsis of optical properties of conductors, insulators and semiconductors. Optical properties of molecular materials.

Nonlinear optical materials and processes. Nonlinear optical susceptibility. Anharmonic oscillator model. Classical and quantum calculation of the second and third order nonlinear optical susceptibility. Materials for second and third order nonlinear optical processes. An electromagnetic coupled wave description of second harmonic generation and of sum or difference frequency generation. Phase matching. Optical Kerr effect and its applications.

TE and TM planar waveguides and electromagnetic modes. Materials for optical waveguides. Waveguide directional couplers and coupled mode theory. Periodic waveguides-Bragg waveguides. Distributed feedback laser. Nonlinear waveguide directional couplers. Photonic band gap materials. Waveguides based on photonic band gap materials and coupled resonator optical waveguides.

MAS_477 Magnetic Materials

Prerequisite Courses: Materials Science I & II.

Overview of the basic magnetostatic theory - Magnetic moment and dipole - Magnetisation and magnetic materials - Hysterisis loops - Atomic origin of magnetism and quantum theory of spin - Diamagnetic materials and their applications - Paramagnetic materials - Curie-Weiss law - Pauli- type paramagnets - Electron interactions in ferromagnetic materials - Weiss-Langevin theory and theory of itinerant electrons - Ferromagnetic domains and dynamics of Bloch-walls - Appearance

of hysteresis in ferromagnetic materials - Soft and hard magnets - Antiferromagnetc materials - Ferrimagnetic materials (ferrites, garnets) and their applications - Intrinsic and induced magnetic anisotropy - Its application in magnetic storage media and properties of small magnetic particles - Giant magnetoresistance and hard-discs reading-heads - Collosal magnetoresistance and perpsectives - Kerr effect and magneto-optical recording - Nanostructured magnetic materials with applications in magnetoelectronics (transistors, random-access magnetic memories, sensors) - Perspectives of nanophased magnetic materials (magnetoelectric materials, multiferroics) and their relation to cutting-edge technology.

MAS_479 Composite Materials

Prerequisite Courses: Materials Science III.

Introduction: Classification of composite materials. Heterogeneity and anisotropy. Matrix material (polymers, metals, ceramics). Reinforcing materials. Nanocomposites.

Processing methods: Autoclave processing. Resin Transfer Moulding. Filament Winding. Pultrusion techniques.

Interfaces: Adhesion and interactions at the interface. Tailoring the interface. Stress transfer models.

Metal matrix composites: processing and properties.

Ceramic matric composites: processing and properties. Polymer matrix composites: processing and properties.

Mechanical properties: Stiffness and strength of composites. Mechanical anisotropy. Unidirectional and multidirectional composites. Mechanisms of failure.

Thermal behaviour: Thermal expansion and conductivity. Heat capacity. Residual thermal stresses. Hydrothermal properties.

Electrical behaviour: The law of mixtures. Dielectric behaviour and failure. Electrical conductivity. Nanocomposites.

Lab exercises:

Processing laminate composite materials.
Dynamic mechanical analysis of polymer matrix composite materials.
Dielectric response of polymer matrix composite materials.

MAS_4710 Photonics

Prerequisite Courses: Materials Science I & II, Physics IV.

Paraxial optics, Algebra ABCD, Generalized optical system, Design, Aberrations, Polarisation optics, Algebras Jones and Mueller, active polarization elements, Wave propagation, Optical coherence and interference, Fourier Optics, Abbe theory, Optical transfer functions (OTF, MTF) Optical resonators, optical feedback and waveguiding optics, Applications.

MAS_4711 Industrial Metals and Alloys

Prerequisite Courses: Materials Science I and II.

Design philosophy with materials. The evolution of technological metallic materials. The design process. Types of design. The four-fold function, material, shape and production process. Select Materials. Properties. Maps.
Classification of metallic alloys: ferrous, non-ferrous. Processing methods. Role of alloy elements in steels. Examples and design with lightweight materials: Advanced metal alloys for aerospace / vehicle industry: magnesium alloys, aluminum alloys (such as aluminum-lithium etc.). Advanced titanium alloys: alpha and beta types of alloys. Alloys and Superalloys of Nickel. Designing for maximum durability and dyspnoea: High strength steel. Two-phase steel (ferrite-martensite). Thermomechanical treatments. High-plastic pitching. Designing for high temperatures: Creep-
resistant steel. Nickel and cobalt nickel alloys. Other high temperature metals: niobium, molybdenum, tungsten.

MAS_4712 Introduction to Group theory and its application to Materials Science

Prerequisite Courses: Applied Mathematics I and II.

Group theory. Abelian groups. Isomorphism. Symmetry elements and point groups. Symmetry elements and operations. Classification of point groups. Generators. Finding the point group that a molecule belongs to. Group representations including matrices. Irreducible and reducible representations. The great orthogonality theorem (GOT). The small orthogonality theorem. Theorems about irreducible representations. Relation between representation theory and quantum mechanics. Basis functions. Projection and Transfer Operators. Matrix characters and their simple usage. Examples: symmetry of physical properties, tensor symmetries. Theory of molecular orbitals and group theory. LCAO orbitals symmetries. Symmetries and form of hybrid orbitals for sigma and pi bonds. Direct product groups, matrix elements, selection rules. Number and symmetry of normal modes in Molecules. Vibronic wave functions. IR and Raman selection rules. Resonance Raman. Electronic transitions in diatomic molecules. Single, double, triple bonds and lone pairs. **Laboratory exercises**: Measurement of IR and UV/Vis materials' spectra with various types of symmetries.

MAS_4713 Materials and the Environment

Prerequisite Courses: Materials Science I.

Interactions of materials with the environment and their application in contemporary technologies for environmental remediation. Environmental implications of commonly used materials. Environmental contamination. Physical chemistry of materials and processes at the solid-liquid interface. Heterogeneous catalysis. Adsorbents/porous materials. Molecular imprinting. Biodegradable polymers and recycling. Safety during materials and chemicals handling.

The course includes obligatory seminars on the basics of scientific text writing, on bibliography search on scientific databases and oral presentation or lab exercises.

MAS_4714 Electronic Structure of Materials

Prerequisite Courses: Introduction to Quantum Mechanics.

Introduction to the theoretical background of electronic structure calculations, quantum chemistry and computational solid state physics.

A. direct space methods. Schrödinger equation for multi-electron atoms and molecules. The Hartree-Fock approximation in its restricted (RHF) and unrestricted (UHF) forms. Linear combination of atomic orbitals (LCAO). Introduction of a basis set in Hartree-Fock, derivation of Roothan-Hall and Pople-Nesbet equations. Two electron integrals and the standard notation of the field (physicist's and chemist's notation). Interpretation of Hartree-Fock results, Koopmans theorem and Mulliken population analysis. Electron correlation, post Hartree-Fock methods (Møller–Plesset perturbation theory, configuration interaction etc.). Basis sets. Molecular symmetry, point groups, irreducible representations and Schoenflies notation.

Introduction to density functional theory. The Hohenberg–Kohn theorems. The Kohn-sham equations. Exchange-correlation energy and types of approximate functionals (LDA, GGA, hybrid etc.).

A brief presentation of popular quantum chemistry programs and tools. Design of standard quantum chemistry calculations (total energy, geometry optimization, vibrational frequencies etc.)

B. Reciprocal space methods. Kohn-Sham equations in k space. The role of exchange and correlation. Self-consistency in first principles calculations. Systems with periodic boundary conditions (like bulk systems, compounds, surfaces, interfaces, multilayers, heterostructures), field of application, advantages and disadvantages. Classification of methods in all electron, pseudopotential and tight binding methods. Pseudopotentials and plane wave expansion of the wavefunction. Common types of calculations: total energy, geometry optimization, cell optimization, band structure, density of states, elastic properties, magnetism and phonons. Computation of disorder, defects and impurities.

Brief introduction of related codes. Design of systems with periodic boundary and calculations with open source software. Post-processing and result visualization.

MAS_4715 Applied Quantum Mechanics

Prerequisite Courses: Introduction to Quantum Mechanics.

Basic features: time-dependent and time-independent Schrödinger equation, wavefunction, probability amplitude and probability current density, superpositions, operators, expectation values, and uncertainty principle. Free particle and effective mass approximation in semiconductors. Inversion symmetry of the potential and symmetry of the wavefunctions. Dirac formalism and matrix formulation of quantum mechanics.

Quantum mechanics in basic systems: bound states in simple and complex one-dimensional potential wells and applications in semiconductor nanostructures and heterostructures. The infinite potential well with symmetric boundaries. Combination of an infinite potential well

and a finite potential well. The symmetric finite potential well and connection with semiconducting quantum wells. The delta function potential. The triangular well potential and its application to MOSFET. Numerical solutions of the time-independent Schrödinger equation.

Scattering in one dimensional quantum structures. Applications in simple and complex potentials, including delta function potentials. The propagation matrix. WKB approximation for scattering. Applications in semiconductor nanostructures.

Periodic potentials and applications in solids with emphasis in semiconductors. Tight binding method and application in a simple one-dimensional lattice. Applications of tight-binding in graphene and in the Su-Schrieffer–Heeger (SSH) topological model for materials.

The harmonic oscillator: standard solution and algebraic solution (description with creation and annihilation operators); applications in quantum nanostructures and electromagnetic fields and their quantization, photons. Quantization of the LC circuit. Quantization of harmonic lattice, phonons. Free electron in a magnetic field - Landau states and connection to the semiclassical orbit.

Quantum confinement in three-dimensions: separable potentials, central potentials, and applications in three-dimensional semiconductor nanostructures ("hard" spherical potential and finite spherical potential) and the hydrogen-like systems and applications in defects in semiconductors and excitons in semiconductors.

Angular momentum and spin.

Quantum mechanics of semiconductor quantum wells, wires and dots.

Time-independent perturbation theory and its applications. Examples, Stark effect in quantum wells and the displayed harmonic oscillator. Time-independent degenerate perturbation theory and applications, the sudden approximation, and applications in nanostructures. The WKB approach for bound states and applications related to low-dimensional systems.

Eighth Semester

MAS_482 Surface Science-Thin Films

Prerequisite Courses: Materials Science I, II, Physical Chemistry I, Laboratory of Physical Chemistry.

Introduction. Thermodynamics and reactivity of surfaces. Interaction of molecules with surfaces. Physical and chemical adsorption. Methods of film preparation without the need of vacuum. High and Ultrahigh vacuum. Vacuum chambers. Physical and chemical vapor deposition techniques.growth habits. Ultrathin Films. Characterization of thin films and surfaces. Nanostructured films and preparation methods of them. Electronic property modification in ultrathin and nanostructured films. Technological applications of thin films.
Laboratory: Vacuum pumps and vacuum chamber, Thin Film growth by sputtering, X-ray diffraction characterization of thin films, Atomic Force Microscopy on Thin Films.

MAS_483 Smart Materials

Prerequisite Courses: Materials Science I, Physics III, Laboratory III of Physics.

A' part: Dielectric materials: Introduction, Dielectrics in static field, Dielectrics in time

dependent
field, Piezoelectrics, Ferroelectrics, Pyroelectrics.
B' part: Smart Materials: Introduction, Sensing and actuating technologies, Electro rheological fluids, Composite systems with shape memory materials, Composite systems with piezoelectric elements, Optic sensors.
Laboratory: Dielectric response of insulating materials – relaxation effects.
Evaluation of the conductive phase content in polymer matrix/metallic inclusions composites. Study of the phase transformations in shape memory alloys by means of Differential Scanning Calorimetry (DSC).
Dynamic mechanical response of shape memory alloys.

MAS_484 Semiconductor Materials and Devices

Prerequisite Courses: Materials Science V, Introduction to Quantum Mechanics.

THEORY
Introduction. Methods of preparation. Crystallic structure of semiconductors with technological interest. Elementary semiconductors, semiconductor compounds III-V, II-VI, semiconductor oxides semiconductor alloys, amorphous semiconductors, organic semiconductors. Energy diagrams and density of energy states in two, one and zero dimensions. Excitons and Biexcitons. Semiconductor nanoparticles: physical and chemical preparation methods, phase transitions, linear and non-linear optical properties. Coulomb blockade and single electron tunneling in quantum dots. Composites of quantum dots and conjugate polymer. Applications: Semiconductor laser,
photovoltaic solar cells, quantum dots for optical data storage. Semiconductor nanowires, physical and chemical preparation methods, applications. Nanoelectronics.

LABORATORY EXPERIMENTS
Determination of semiconductor energy gap by ultraviolet spectroscopy.
Synthesis and optical characterization of semiconductor nanoparticles.
Synthesis and optical characterization of semiconductor nanowires.
Optical characterization of semiconductor thin films.
Modeling and determination of the optical energy gap of semiconductor nanostructured materials of a given geometry.
Measurement of dc electrical conductivity of organic semiconductors as a function of temperature.

MAS_485 Topics in Industrial and Technological Applications of Materials II Topics in Industrial and Technological Applications of Materials II

Prerequisite Courses: Materials Science I, II and III.

The course includes a series of lectures concerning industrial and technological applications of materials. The lectures are given mainly by industry/organizations executives with high academic knowledge and expertise in a wide range of materials science applications.

MAS_486 Ceramics and Glasses

Prerequisite Courses: Chemistry I, Materials Science II, Physical Chemistry I.

Ceramics: Properties and purification of raw materials. Methods of phase analysis. Methods of production. Refractory. Magnetic ceramics. Dielectric ceramics. Porcelain items.

Glass: Structure of glass. Methods of structure analysis. Physical properties of glasses. Chemical properties of glasses. Technological applications. Methods of glass production.

MAS_487 Advanced Biomaterials

Prerequisite Courses: Materials Science IV, Cell Biology I, II.

Applications of materials in Pharmaceutics. Methods of drug delivery. Controlled drug delivery. Materials as carriers of bioactive compounds: nanoparticles and liposomes. Biodegradable systems based on poly (lactic-co-glycolic acid) copolymer. Emulsions. Transdermal drug delivery. Magnetic nanoparticles. Alginic acid hydrogels. Materials used as bone substitutes. Calcium Phosphate bone cements. Dental cements. Design and development of biomaterials with antibacterial properties. Use of biopolymers in skin regeneration. Bioartificial liver and pancreas. Coronary stents. Materials to close skin wounds, Surgical sutures and staples. Biological glues. Patches. Self-adhesive tapes. Toxicity, safety and side effects of nanosystems. Regulatory network for nanotechnology drugs approval. Rules of conduct for the application and use of nanotechnology.
Laboratory exercises (demonstration): Preparation of liposomes, Synthesis of magnetic nanoparticles, synthesis of calcium alginate hydrogels, preparation of dental cements, preparation of calcium phosphate bone cements.

MAS_488 Applications of Optoelectronics

Prerequisite Courses: Materials Science II, Physics IV.

Passive photonic structures: interferometric optical elements. Optical cavities. Optical filters. Diffractive optical elements, holographic filters. Optical waveguides and optical fibers. Advanced photonic cavities. Photonic Crystals. Optical couplers.

Light sources: thermal sources, laser diodes and LEDs. Semiconductor lasers. Semiconductor optical amplifiers. Fiber optical amplifiers.
Light detectors: thermal and quantum detectors.
Electrooptic, acoustooptic and magnetoptic structures. Optical modulators. Optical isolators and circulators.
Photonic applications: Optical communications, Photonic integrated circuits. Optical sensors. Biophotonics and medical applications.

MAS_489 Introduction to Materials and Processes of Quantum Electronics

Prerequisite Courses: Introduction to Quantum Mechanics.

Basic materials and systems for quantum electronic processes: atomic-molecular systems, semiconductors, semiconductor quantum wells and quantum dots, ion-doped crystals.
Methods for modeling interaction of light with materials: probability amplitude and density matrix approach. Description and modeling of decay and dephasing processes in systems used in quantum electronics. Optical Bloch equations for semiconductors.
Methods for population transfer between quantum states: Rabi oscillations and adiabatic population transfer.
Quantum description of absorption and dispersion in materials. Linear and nonlinear optical response of excitons. Control of absorption and dispersion in quantum systems: self-induced transparency electromagnetically induced transparency and slow light. Lasing without inversion. Propagation in phase coherent media. Light storage and retrieval in quantum systems. Enhanced nonlinear optics with electromagnetically induced transparency. Enhanced parametric generation in phase coherent media.
Linear and nonlinear electron waveguides.
Basic elements of quantum computation: quantum bit and systems for its realization.

Entangled states. Quantum gates. Basic quantum circuits.

MAS_4811 Molecular Nanomaterials

Prerequisite Courses: Physics IV, Materials Science V.

Theory in characterization techniques of molecular nanomaterials such as XRD, SEM, spectroscopic STM, optical absorption and luminescence in the visible and ultraviolet range, Raman, Resonance Raman, techniques Surface IR, XPS, NSOM, electroluminescence, photoconductivity and reflectivity techniques thin films. techniques for determining electrical properties. Techniques/methodologies of synthesis of nano-dimensioned metallic and semiconducting nanomaterials including chemical and physical processes, which can have device applications in optoelectronics.

Laboratory exercises. Synthesis, characterization and determination of properties of the following materials/devices.
1) Molecular low dimensioned quantum wells.
2) Metal nanoparticles and silver nanoprisms.
3) Solar modules based on hybrid-molecular structures of nanoporous materials.
4) Quantum dots based on CdS.
5) Light-emitting diodes based on either molecular materials or on low dimensioned quantum wells.
6) Hybrids porous inorganic matrices and quantum dots.

MAS_4812 Microtechnology and nanotechnology

Prerequisite Courses: Materials Science I & II, Physics IV.

Growth and processing of semiconductor and related materials. Processing methods and fabrication technologies. Epitaxial methods. Micro- and nano-lithographic processing. Soft lithography and nanoimprint lithography. Applications in microelectronics and photonics.

MAS_4813 History and Philosophy of Natural Sciences

Prerequisite Courses: None.

1st Unity
(1) From classical Empiricism to Logical Positivism ('Vienna Circle', 1920-1930).
(2) The transition to the 'historicistic turn' (1960's decade).
(3) Characteristics of scientific research and methods, it's aims. Distinction between sciences and
pseudosciences.
(4) The history of ideas on 'scientific method'. Induction. Falsificationism.
(5) Philosophical views on scientific 'change' and scientific 'progress'. Rationalism. Relativism.
(6) Scientific realism vs. anti-realism debate. In the laboratory. Theory and observation.
(7) Some aspects of 'Continental Philosophy of Science'.

2nd Unity
(1) Ancient Greece. Physical philosophy of Aristotle.
(2) First Medieval Universities. European physical sciences in the Middle Ages.
(3) The history and significance of 'Scientific Revolution' in Western Europe. Sciences and
Enlightenment.
(4) Historiographical elements: for the history of history of science. Cultural and Social History of Sciences.
(5) From 'History and Philosophy of Science' to 'Science and Technology Studies'.
(6) The sociology of scientific knowledge. Contemporary debates over 'Social Studies of

Science' 'Gender and Science'.

MAS_4814 Amorphous Alloys and Nanostructured

Materials Prerequisite Courses: Materials Science I-III,

Physics I-III. Timeline evolution of amorphous metals and

their properties.
Nanostructured materials: structure, properties, fabrication methods, characterization, applications. Metallic nanoparticles: optical properties, plasmons.

MAS_473 Scientific Review

Prerequisite Courses: Student should have gathered 96 ECTS.

In the Scientific Review, student is expected to produce a scientific report of about 5000 words covering the literature for a specific subject.

MAS_481 Diploma Thesis

Prerequisite Courses: Scientific Review and the accordance of the supervisor.

Diploma Thesis is the research part of the Diploma Thesis and follows Scientific Review which is purely bibliographical.

MAS_491 Industrial Training

Prerequisite Courses: Student should have gathered 96 ECTS.

Students practices in the chosen industry on a predefined subject for three months.

MAS_492 Training through the Erasmus Mobility Program

Prerequisite Courses: Student should have gathered 96 ECTS.

Students practices in the chosen foreign industry on a predefined subject.