Faculty of Natural Sciences

IMPORTANT NOTES

If for one subject you can find several different types (lecture, practice, laboratory) of courses then please choose one and only one course from each type in order to be able to perform the subject's requirements successfully.Civil Engineering courses are on the website seperately. Courses chosen from the offer of Faculty of Civil Engineering will be checked and arranged individually by the departmental coordinator.

Subject code	Subject name	Requirement	ECTS credit
BMETE11AF39	Measurement Control Project Work in LabVIEW Environment	Mid-semester mark	3

Course type	Course code	Course language	Timetable information
Laboratory	E1	English	MON:08:15-12:00(F3213)

Subject code	Subject name	Requirement	ECTS credit
BMETE11AX13	Physics for Civil Engineers	Mid-semester mark	2

Course type	Course code	Course language	Timetable information
Lecture	En0	English	

Basics of mechanics: the essence of physics, modeling, basic concept of measurement, experiments, standard of units, kinematics, curvilinear motion, circular motion, basic laws of dynamics, Newton’s laws, the problem of weight, special forces, the universality of gravity, planetary motion; friction and air-resistance, work, energy, power, energy conservation and work-energy theorem, linear momentum, impulse, collisions, ballistic pendulum, extended objects, rigid bodies, rotation, angular momentum, moment of inertia. Basics of thermodynamics: pressure, Pascal’s law, atmospheric pressure, Archimed’s law, buoyancy, flow of gases and liquids, Bernoulli’s equation, temperature, thermal equilibrium, absolute scale, thermal expansion, phase-transitions, concept of ideal gases, state-equation of an ideal gas, Joule experiment, work done on/bye the gas, heat exchange, internal energy, equipartition theorem, special processes (isobar, isochor, isotherm, adiabatic), 1st law of thermodynamics.Required knowledge: Basics of undergraduate mathematics (analysis, ordinary differential equations, integration).

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF09	Professional Practice RP	Signature	0

Course type	Course code	Course language	Timetable information
Laboratory	E1	English	

The prerequisit to registering this course is successful completion of the course Independent laboratory RP1. The student performs research tasks related to the diploma work topic for 3 weeks, anytime during the summer holiday, under the guidance of the thesis advisor. The signature indicating completion of this course will be entered to Neptun by the responsible teacher, based on the suggestion of the thesis advisor.

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF26	Physics of Semiconductors	Exam	3

Course type	Course code	Course language	Timetable information
Lecture	T0	English	TUE:12:15-14:00

Introduction: importance of semiconductor physics, modern applications, the limitations of electronics. Charge carriers in semiconductors: band structure, envelope function, lattice distortions, impurities, localized states, shallow and deep levels. Band structure of semiconductors: spin-orbit interaction, kp model. Transport phenomena: quasiclassical dynamics, Boltzmann equation, conductivity, Hall-effect, magnetoresistance, thermoelectric and thermomagnetic phenomena. Diffusive phenomena in semiconductors: inhomogeneous semiconductors, diffusion, diffúzió, Einstein-relation, conduction, Gunn-diode, p-n junction, Zener-diode, tunnel diode, bipolar transistors, JFET. Characterization and engineering of semiconductors: traditional and epitaxial growth, characterization techniques, lattice matching, band-engineering, heterostructures, superlattices, highe electron mobility 2DEG and its high frequency applications, fabrication of semiconductor nanostructures. Field effect and its applications: surface density of states, remote doping, Schottky barrier, Schottky diode, ohmic contacts, MOS-structures, High-k dielectrics, flash memories, solar cells, CCD devices, the fundamentals of CMOS technológy. Optical properties of semiconductors: interaction with light, photoconduction, absorpion of free charge carriers, recombination mechanisms, the principles and applications of light emitting diodes and semiconductor lasers.

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF32	Independent Laboratory RP2	Mid-semester mark	13

Course type	Course code	Course language	Timetable information
Laboratory	E1	English	

The student must have chosen a diploma work topic before registering to this course. The student performs research tasks related to the diploma work topic during the semester, under the guidance of the thesis advisor.

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF33	Diploma Work RP	Mid-semester mark	30

Course type	Course code	Course language	Timetable information
Laboratory	E1	English	

The prerequisit to registering this course is successful completion of the course Independent laboratory RP2. The student performs research tasks related to the diploma work topic during the semester, under the guidance of the thesis advisor.

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF38	Chemistry in Nanotechnology	Exam	3

Course type	Course code	Course language	Timetable information
Lecture	T0	English	MON:14:15-16:00

The course presents recent developments in nanotechnology and nanoscience using chemical methods. We will overview measurement techniques for nanosclae building blocks, namely transmission electron microscopy (TEM), scanning electron microscopy (SEM), dynamic light scattering (DLS). Synthesis of nanoparticles: chemical, physical and biological methods and chemical stabilization of nanoparticles. Purification and size and shape-selective purification of nanoparticles. The stability of nanoparticles and interactions existing at nanoscale and using them for the self-assembly of nanoscopic components: nanostuctured materials. Usage of nanoparticles in chemistry, medicine and chemical robotics. Targeted drug delivery applications.

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF45	Superconductivity	Exam	3

Course type	Course code	Course language	Timetable information
Lecture	T0	English	WED:14:15-16:00

Phenomenology of superconductors. Meissner effect, London equations, electrodynamics of superconductors. Bardeen-Cooper-Schrieffer theory: ground state, thermodynamic and transport properties. Ginzburg-Landau theory: free energy, GL equations and their solution, Abrikosov vortices, magnetic properties of Type II superconductors. Josephson effect and its applications. High-temperature superconductors. Prerequisites: Modern Solid State Physics.

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF55	Modern Solid State Physics	Exam	7

Course type	Course code	Course language	Timetable information
Lecture	T0	English	THU:09:15-12:00
Practice	T1	English	WED:16:15-18:00

Course designed for the Physicist MSc education. Only those with Physics BSc diploma are allowed to register for this course.#160;This course describes the behavior of interacting many body systems (mainly electron systems) building on solid state physics and statistical physics knowledge gained while earning a BSC degree in Physics. The following topics are discussed: identical particles, second quantization, interacting electron systems in Bloch and Wannier representation, itinerant ferromagnetism, linear response theory, susceptibility of metals, spin density waves, Bose liquid.#160;

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF58	Nanotechnology and Materials Science	Exam	5

Course type	Course code	Course language	Timetable information
Lecture	T0	English	WED:09:15-12:00

This course gives an introduction to the main trends in nanotechnology and material science. We cover advanced fabrication and measurement techniques by giving examples from state-of-the-art research and development results. The course addresses the following topics: Novel concepts and modern material systems in nanotechnology. Advanced imaging methods from electron microscopy to atomic resolution scanning probe techniques. Top-down nanofabrication techniques: photo and electron beam litography, deposition and special patterning techniques. Bottom-up approaches and self-organizing nanostructures. Semiconductor technology and novel concepts in information technologies. Investigation of electronic and vibrational properties by optical spectroscopy. Advanced surface analysis techniques.

Subject code	Subject name	Requirement	ECTS credit
BMETE13AM16	Physics 1 for Mathematicians	Mid-semester mark	2

Course type	Course code	Course language	Timetable information
Lecture	E0	English	

Review of the physics we learned in secondary school: Newton's laws, Conservation laws. Inertial frame of reference, general transformation between two Inertial frame of reference. Galilei transformation, Lorentz transformation. Introduction to special relativity: Lorentz contraction, time dilation, proper time, invariant quantities. Four vectors. Accelerated Reference Frames, Fictitious force: Coriolis force, Foucault pendulum, centrifugal force. Demonstration experiments. Primer to geometrical optics, Fermat's principle, Euler-Lagrange equation. Hamilton's principle, Lagrange function, equation of motion. Relation between the symmetry of the Lagrangian and the conservation laws, Noether's theorem. Application of the law of conservation, motion in central field. Kepler problem.

Subject code	Subject name	Requirement	ECTS credit
BMETE15AF45	Classical and Quantum Chaos	Exam	3

Course type	Course code	Course language	Timetable information
Lecture	T0	English	FRI:14:15-16:00

Subject code	Subject name	Requirement	ECTS credit
BMETE15MF60	Quantum Computing Architectures	Exam	3

Course type	Course code	Course language	Timetable information
Lecture	T0	English	WED:12:15-14:00(F3M01)

Subject code	Subject name	Requirement	ECTS credit
BMETE15MF67	Quantum Optics	Exam	5

Course type	Course code	Course language	Timetable information
Lecture	T0	English	WED:16:15-18:00
Practice	T1	English	WED:18:15-19:00

The course is an introduction to quantum optics. The topics covered are:1. Coherence in classical optics2. Radiative transitions in quantum matter, atoms and semiconductors3. Photodetection, photon statistics, super- and sub-Poissonian light4. Hanbury-Brown and Twiss interferometry, photon antibunching5. Coherent and squeezed states, Wigner functions6. Resonant light-atom interaction, density states, Rabi oscillation7. Atoms in cavities, Purcell effect, strong coupling8. Cold atoms, Bose condensation, optical lattices9. Quantum cryptography and quantum information10. Entanglement, quantum teleportation, Bell inequalitiesQuantum Optics: an Introduction, Mark Fox, OXFORD MASTER SERIES IN PHYSICS, Oxford University Press 2006, ISBN-13: 978ndash;0ndash;19ndash;856673ndash;1 OP

Subject code	Subject name	Requirement	ECTS credit
BMETE15MF75	Artificial Intelligence in Data Science	Mid-semester mark	5

Course type	Course code	Course language	Timetable information
Lecture	TA0	English	THU:16:15-17:00(F3213)
Practice	TA1	English	THU:17:15-19:00(F3213)

Aim: Introduction to machine learning from a physicist's perspective, with the aim to understand how it works and less emphasis on tricks or parameter optimization.Subjects: Regression. Image segmentation. Decision tree. Deep learning (from scratch in numpy). Higher level implementations (tensorflow, sklearn, keras). Convolutional neural networks. Pre-trained models. Data augmentation. Textual data. Sequential data. Game models.

Subject code	Subject name	Requirement	ECTS credit
BMETE80MX00	Nuclear and Reactor Physics Fundamentals	Exam	5

Course type	Course code	Course language	Timetable information
Lecture	T0	English	TUE:14:15-17:00
Practice	T1	English	TUE:17:15-18:00

Subject code	Subject name	Requirement	ECTS credit
BMETE80NE02	Fusion Devices	Mid-semester mark	4

Course type	Course code	Course language	Timetable information
Laboratory	T1	English	MON:14:15-15:00
Lecture	T0	English	MON:12:15-14:00

The course starts with two introductory lectures: the first one summarizes the physics basis needed to understand the criteria for fusion energy producing devices, while the second reviews the main elements of fusion technology and their functions. This is followed by two lectures of introduction to stellarator technology through the German stellarator program, and three leactures dealing with the past, present and future of tokamaks. Spherical tokamaks are discussed in a separate lecture followed by lectures introducing the most important milestones of German, US and Japanese fusion programs. The last lecture presents the rapidly expanding Far-East fusion programs in the context of the history of superconducting tokamaks.#160;

Subject code	Subject name	Requirement	ECTS credit
BMETE90AX00	Mathematics A1a - Calculus	Exam	6

Course type	Course code	Course language	Timetable information
Lecture	EN-EMK-0	English	TUE:14:15-16:00(KF88); TUE:14:15-16:00(KF88); WED:16:15-18:00(KF88); WED:16:15-18:00(KF88)
Lecture	EN-VBK-0	English	
Lecture	EN-VIK-0	English	MON:12:15-14:00; TUE:12:15-14:00
Practice	EN-VIK-1	English	WED:10:15-12:00
Practice	EN-EMK-1	English	MON:16:15-18:00(K373); MON:16:15-18:00(K373)
Practice	EN-VBK-1	English	

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Subject code	Subject name	Requirement	ECTS credit
BMETE90AX09	Mathematics A3 for Electrical Engineers	Exam	4

Course type	Course code	Course language	Timetable information
Lecture	EN0	English	TUE:10:15-12:00
Practice	EN1	English	MON:14:15-16:00

Differential geometry of curves and surfaces. Tangent and normal vector, curvature. Length of curves. Tangent plane, surface measure. Scalar and vector fields. Differentiation of vector fields, divergence and curl. Line and surface integrals. Potential theory. Conservative fields, potential. Independence of line integrals of the path. Theorems of Gauss and Stokes, the Green formulae. Examples and applications. Complex functions. Elementary functions, limit and continuity. Differentiation of complex functions, Cauchy-Riemann equations, harmonic functions. Complex line integrals. The fundamental theorem of function theory. Regular functions, independence of line integrals of the path. Cauchy's formulae, Liouville's theorem. Complex power series. Analytic functions, Taylor expansion. Classification of singularities, meromorphic functions, Laurent series. Residual calculation of selected integrals. Laplace transform. Definition and elementary rules. The Laplace transform of derivatives. Transforms of elementary functions. The inversion formula. Transfer function. Classification of differential equations. Existence and uniqueness of solutions. The homogeneous linear equation of first order. Problems leading to ordinary differential equations. Electrical networks, reduction of higher order equations and systems to first order systems.The linear equation of second order. Harmonic oscillators. Damped and forced oscillations. Variation of constants, the in-homogeneous equation. General solution via convolution, the method of Laplace transform. Nonlinear differential equations. Autonomous equations, separation of variables. Nonlinear vibrations, solution by expansion. Numerical solution. Linear differential equations. Solving linear systems with constant coefficients in the case of different eigenvalues. The inhomogeneous problem, Laplace transform. Stability.

Subject code	Subject name	Requirement	ECTS credit
BMETE90AX18	Mathematics A3 for Chemical Engineers and Bioengineers	Exam	4

Course type	Course code	Course language	Timetable information
Lecture	EN-CA0	English	
Practice	EN-CA1	English	

Subject code	Subject name	Requirement	ECTS credit
BMETE90AX21	Calculus 1 for Informaticians	Exam	6

Course type	Course code	Course language	Timetable information
Lecture	EN0	English	MON:10:15-12:00; TUE:10:15-12:00
Practice	EN1	English	WED:10:15-12:00

Subject code	Subject name	Requirement	ECTS credit
BMETE90AX33	Mathematics EP1	Exam	4

Course type	Course code	Course language	Timetable information
Lecture	EN0	English	
Practice	EN1	English	

This course covers the elements of single variable calculus and linear algebra. Special emphasis is put on the concepts of linear algebra which are later used by architects in structural design. These are the systems of linear equations, matrices and determinants with their properties. From the elements of calculus, the limit of sequences, the differentiation, the integration and applications belong to the course material.

Subject code	Subject name	Requirement	ECTS credit
BMETE91AM36	Introduction to Algebra 1	Exam	9

Course type	Course code	Course language	Timetable information
Lecture	A0	English	MON:10:15-12:00; TUE:10:15-12:00
Practice	A1	English	MON:14:15-16:00; THU:14:15-16:00

Elementary number theory: integers, divisibility, division with remainders, greatest comon divisor, Euclidean algorithm, irreducible numbers and prime numbers,Fundamental Theorem of Arithmetic. Linear Diophantine equations, modular arithmetic, complete and reduced remainder systems, solution of linear congruences. Complex numbers, algebraic and trigonometric forms, Binomial Theorem. Relation between the complex numbers and the geometry of the plane. Roots of unity, primitive roots of unity. Polynomials with one variable, operations, Horner-scheme, rational root test, Fundamental Theorem of Algebra. Irreducibility of polinomials, Schönemann-Eisenstein criterion. Multivariate polynomials, complete and elementary symmetric polynomials, Viete formulas, roots of cubic polynomials. Systems of linear equations in two and three variables, Gaussian and Gauss-Jordan elimination. R^n and its subspaces. Linear combinations, linear independence, spanned subspace, basis, dimension. Coordinate systems, row space, column space, nullspace of a matrix. Subspace of solutions, solutions in the row space. Matrix operations, inverse matrix, base change matrix. Operations with special matrices, PLU decomposition. Solution of systems of equations with the help of PLU decomposition. Determinant as the volume of the parallelepiped. Basic properties, determinant of a matrix. The notion of permutations, transpositions, cycles, expansion of the determinant. Laplace Expansion Theorem, Mutiplication Theorem of Matrices, formula for the inverse of a matrix, Cramer's Rule. Basic properties of matrix rank. Linear maps and their matrices: the matirx of a projection to a subspace. Similar matrices. Optimal solution of inconsistent systems of linear equations, normal equation, solution in the row space and its minimality. Moore-Penrose generalized inverse.– W. Sierpinski: Elementary theory of numbers, North Holland, 1987.– P. Halmos: Finite dimensional vector spaces, Springer, 1967.– V.V. Prasolov, Problems and Theorems in Linear Algebra, AMS, 1994.– P. Halmos C.D. Meyer: Matrix analysis and applied linear algebra (online textbook)– J. Hefferon: Linear Algebra, free online book– K.H. Rosen: Elementary Number Theory and Its Application, 6th Edition, Pearson, 2010.– C.D. Meyer: Matrix Analysis and Applied Linear Algebra, SIAM, 2000.– K.H. Rosen: Elementary Number Theory, Pearson (2011) (online textbook)

Subject code	Subject name	Requirement	ECTS credit
BMETE91AM38	Algebra 1	Exam	7

Course type	Course code	Course language	Timetable information
Lecture	A0	English	THU:09:15-12:00
Practice	A1	English	MON:14:15-16:00

Groups, semigroups. Basic properties of groups, group homomorphism, subgroups, cosets. Langrange's Theorem. Examples: diherdral groups, quaternion group, symmetric groups, alternating groups. Decomposition of permutations into disjoint cycles, transpositions. Permutation groups, group actions, transitivity, Cayley's Theorem. Cyclic groups, order of a group element. Cauchy's Theorem. Direct product of groups. Normal subgroups, factor group, Homomorphism Theorem, Noether's Isomorphism Theorems. Important subgroups: derived subgroup, centre, class equation. Subgroup chains, Sylow's Theorems, description of the structure of groups of small size. Nilpotent groups. Fundamental Theorem of Finite Abelian Groups. Free groups. Free algebras over rings, ideals, maximal and prime ideals. Description of the polynomial ring R[x]. Principal ideal domains. Noether rings, unique factorization domains (UFD). Factor rings, field extensions, construction of finite fields. Modules over rings, submodules, module homomorphisms. Semisimple modules and rings. The structure of matrix algebras over division rings. Vector space and module constructions: factor module, direct product, direct sum, tensor product. Linear fuction and the dual space. – P.J. Cameron: Introduction to Algebra, Oxford Science Publications, 1998.– Atiyah-Macdonald: Introduction

to commutative algebra, online textbook			
Subject code	Subject name	Requirement	ECTS credit
BMETE93BG01	Mathematics G1	Exam	6

Course type	Course code	Course language	Timetable information
Lecture	EN0	English	WED:16:15-19:00(KF82); THU:16:15-17:00(KF82)
Practice	EN1	English	THU:17:15-19:00(KF82)

Subject code	Subject name	Requirement	ECTS credit
BMETE93BG03	Mathematics G3	Mid-semester mark	4

Course type	Course code	Course language	Timetable information
Lecture	EN0	English	TUE:08:15-10:00(KF87)
Practice	EN1	English	WED:08:15-10:00(R513)