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
BMETE119779	MATLAB Programming	Mid-semester mark	3

Course type	Course code	Course language	Timetable information
Laboratory	E1	English	TUE:12:15-14:00(F3213)

Subject code	Subject name	Requirement	ECTS credit
BMETE11AX14	Nobel Prize Physics in Everyday Application	Exam	2

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

Scope: The amazing and explosive development of technology is our everyday experience in various fields of life from informatics and medicine. It is less well known how this development is supported by scientific research. As an example a notebook computer applies numerous Nobel Prize awarded ideas, like the integrated circuits (2000), semiconducting laser (2000), liquid crystal display (1991), CCD camera (2009), GMR sensor of the hard disk (2007) and several further achievements from earlier days of quantum mechanics and solid state physics. The course is intended to give insight to a range of amazing everyday applications that are related to various Nobel Prizes with a special focus on recent achievements. The topics below are reviewed at a simplified level building on high school knowledge of physics. Syllabus:- Textbook applications from the early days of Nobel prizes: wireless broadcasting, X -rays, radioactivity, etc.- Optics in everyday application: lasers, CCD cameras, optical fibers, liquid crystal displays, holography- Quantum physics: from atom models to quantum communication- Measurements with utmost precision: application of Einstein's theory of relativity in GPS systems, atomic clocks, Michelson interferometry, etc.- Nuclear technology from power plants to medical and archeological applications- Advanced physics in medicine: magnetic resonance imaging, computer tomography and positron emission tomography- Semiconductors from the first transistor to mobile communication- Fundamental tools of nanotechnology (scanning probe microscopes, electron beam lithography, etc)- Spintronics from the discovery of electron spin to everyday application in data storage devices- Exotic states of solids in everyday application: superconducting magnets and levitated trains- Towards quot;all carbon electronicsquot;: envisioned and already realized applications of graphene

Subject code	Subject name	Requirement	ECTS credit
BMETE11AX22	Physics 2	Exam	4

Course type	Course code	Course language	Timetable information
Lecture	VN0	German	THU:10:15-12:00(F29)
Lecture	VE0	English	TUE:12:15-14:00(E505)
Practice	VE1	English	TUE:14:15-16:00(E505)
Practice	VN1	German	TUE:14:15-16:00(E406)

Elektrodynamics: Faradayrsquo;s law. Self induction, mutual induction. Magnetic properties of materials. Magnetic data storage. Maxwell equations. Generation, propagation and reflection of electromagnetic waves. Basics of geometrical optics. Wave optics, interference, diffraction. Polarized light. Basics of atomic Physics: Natural and coherent light sources. Physical foundations of optical communication. Matter waves of de Broglie. The Schrouml;dinger equation. The electron structure of atoms. Electron spin. Free-electron theory of metals. Band structure of solids. Superconduction. Quantum-mechanical phenomena in modern electronics. Basics of nuclear physics. Nuclear reactors. Elementary particles. Curiosities in cosmology. Fundamentals of the physics of the atomic kernel, elementary particles, selected topics in cosmology.

Subject code	Subject name	Requirement	ECTS credit
BMETE11AX24	Physics 2i	Exam	4

Course type	Course code	Course language	Timetable information
Lecture	IT0	English	TUE:12:15-14:00(E505)
Lecture	IN0	German	THU:10:15-12:00(F29)
Lecture	IE0	English	TUE:12:15-14:00(E505)

Practice	IE1	English	TUE:14:15-16:00(E505)
Practice	IN1	German	TUE:14:15-16:00(E406)
Practice	IT1	English	TUE:14:15-16:00(E505)

ELECTRIC FIELDS: Electric charges. Coulomb's law. Coulomb's constant and the dielectric constant. Electric field. Electric field of a point charge, a dipole, a group of charges, continuous charge distributions. Electric field lines. GAUSS' LAW: Electric flux. Gauss' law. Applications for charge distributions having a large degree of symmetry. Conductors in electrostatic equilibrium. ELECTRIC POTENTIAL: Potential energy associated with the electrostatic force. Electric potential difference (voltage) and electric potential. Equipotential surfaces. The electric potential of a point charge, a group of charges, a continuous charge distribution. Mathematical relationship between the electric field vector and the electric potential. Charged conductors in electrostatic equilibrium. CAPACITANCE AND DIELECTRICS: Capacitance. Parallel plate capacitor, cylindrical capacitor, spherical capacitor. Parallel and series combination of capacitors. Energy stored in a charged capacitor. The electric dipole in an external electric field: torque, potential energy. Dielectrics. Atomic dipole moments and the polarization vector. Electric susceptibility, relative dielectric constant. The electric displacement vector. Boundary conditions for the electric field vector and the displacement vector. Energy density of the electric field. CURRENT AND RESISTANCE, DIRECT CURRENT CIRCUITS: Electric current. Current density. Ohm's law. resistivity, conductivity, resistance. Power supplied by a battery. Power dissipated in a resistor. Parallel and series combination of resistors. Kirchhoff's rules. RC circuits: charging and discharging a capacitor. MAGNETIC FIELDS. SOURCES OF THE MAGNETIC FIELD: Magnetism. Magnetic field. Magnetic force on a moving charge. Applications: cyclotron, velocity selector. Magnetic force on a current-carrying conductor. Torque on a current loop. The magnetic dipole. The magnetic field strength. The permeability of free space. Analogy between electricity and magnetism (electricity: acts on charges, is created by charges; magnetism: acts on moving charges, is created by moving charges). The Biot-Savart law and some of its applications. Magnetic force between two parallel conductors. The paradoxical nature of the force acting on a moving charge (resolution of the paradox using special relativity). Ampere's law. Applications for a long straight wire and a solenoid. The magnetic flux. Gauss' law in magnetism. The displacement current and the general form of Ampere's law. Magnetism in matter. The magnetization vector. Ferromagnetism, paramagnetism, diamagnetism. Boundary conditions for the magnetic field and the magnetic field strength. FARADAY'S LAW: Faraday's law of induction. Motional emf: a straight conductor moving through a perpendicular magnetic field; emf induced in a rotating bar. Lenz's law. Induced emf and the associated nonconservative electric field. Eddy currents. Maxwell's four equations in integral and differential form. Electromagnetic waves. INDUCTANCE: Self-induction. Self-inductance. RL circuits. Energy stored in an inductor. The energy density of the magnetic field. Mutual inductance. Oscillations in an LC circuit. The RLC series circuit. LIGHT AND OPTICS: Measurements of the speed of light (Roemer, Fizeau). Geometric optics, ray approximation. Reflection. Refraction and Snell's law. Total internal reflection. Huygens' principle. Fermat's principle. Dispersion. INTERFERENCE OF LIGHT WAVES: Spatial and temporal coherence. Young's double slit experiment, the intensity distribution on the screen. Phasor addition of waves. Generalization for N slits. Interference in thin films. Newton's rings. The Michelson interferometer. DIFFRACTION AND POLARIZATION: Fraunhofer diffraction on a single slit, the intensity distribution on the screen. Resolution of a single slit and a circular aperture. Rayleigh's criterion. Diffraction grating. The spectral resolving power of a grating. X-ray diffraction in crystals, the Laue condition. Fresnel zones. Zone plates and phase Fresnel lenses. Polarization of light waves: elliptical, linear, circular polarization. Polarization by selective absorption, reflection (Brewster's law), birefringence, scattering. Optical activity. LASERS AND HOLOGRAPHY: Interaction between light and matter: spontaneous emission, stimulated emission, absorption. Light amplification by population inversion. Resonators. 3-level and 4-level optical pumping. Electrical pumping. Laser types (solid-state, gas, liquid, semiconductor). Properties of laser beams. The basic idea of holography and its difference from conventional photography. Applications of holography. INTRODUCTION TO QUANTUM PHYSICS: Blackbody radiation and Planck's hypothesis. The photoelectric effect. The Compton scattering. Atomic spectra of low pressure gases. Bohr's quantum model of the hydrogen atom. QUANTUM MECHANICS: Wave properties of particles, de Broglie's hypothesis. The double slit experiment with massive particles. The wave function. The uncertainty principle. Particle in a 1D box. The Schrouml;dinger equation. Particle in a well of finite height. Tunneling and its applications. The simple harmonic oscillator.

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF04	Seminar RP2	Mid-semester mark	2

Course type	**Course code**	**Course language**	**Timetable information**
Practice	T1	English	FRI:12:15-14:00

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF06	Seminar RP4	Signature	0

Course type	**Course code**	**Course language**	**Timetable information**
Practice	T1	English	FRI:12:15-14:00

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF12	Group Theory in Solid State Research	Exam	3

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

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF25	Seminar on Nanophysics 1	Mid-semester mark	2

Course type	Course code	Course language	Timetable information
Practice	T1	English	MON:14:15-16:00

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF48	Seminar NA2	Mid-semester mark	2

Course type	Course code	Course language	Timetable information
Practice	T1	English	FRI:12:15-14:00

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF50	Seminar NA4	Signature	0

Course type	Course code	Course language	Timetable information
Practice	T1	English	FRI:12:15-14:00

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF56	Magnetic Resonance	Exam	5

Course type	Course code	Course language	Timetable information
Lecture	T0	English	WED:14:15-16:00(F3M01)
Practice	T1	English	WED:16:15-17:00(F3M01)

Subject code	Subject name	Requirement	ECTS credit
BMETE11MF57	Theory of Magnetism	Exam	5

Course type	Course code	Course language	Timetable information
Lecture	T0	English	THU:11:15-13:00(F3M01)
Practice	T1	English	THU:13:15-14:00(F3M01)

Landau levels and the basics of the quantized Hall effect. Magnetism of extended electron states, magnetism of atoms and ions. The magnetite. Direct exchange, kinetic exchange. Mott transition, Mott insulators. The Heisenberg model as the low energy effective Hamiltonian of the half filled large U Hubbard model. Heisenberg magnets, the mean field, and spin wave theory of magnetic ordering. Patrik Fazekas: Lecture notes on electron correlation and magnetism, World, Singapore, 1999

Subject code	Subject name	Requirement	ECTS credit
BMETE11MX22	Physics Laboratory for Civil Engineers	Mid-semester mark	1

Course type	Course code	Course language	Timetable information
Laboratory	EA1	English	WED:14:15-18:00(F32L1); WED:14:15-18:00(F32L1)
Laboratory	EA2	English	TUE:14:15-18:00(F32L1); TUE:14:15-18:00(F32L1)

Subject code	Subject name	Requirement	ECTS credit
BMETE11MX33	MSc Physics	Exam	4

Course type	Course code	Course language	Timetable information
Lecture	VE0	English	MON:12:15-14:00(E405); MON:12:15-14:00(E405); THU:10:15-12:00(E402)
Practice	VE1	English	THU:10:15-12:00(E402)

The course covers introduction to two disciplines: Quantum Mechanics and Solid State Physics. After the semester students should be able to understand the basic principles behind these two disciplines and solve some simple problems. This will contribute to the understanding of the workings of modern electronics and nanotechnology. Quantum mechanics: Experimental antecedents.The Wave function.Time dependent and time independent

Schrouml;dinger's equation.Simple problems. Tunneling. Angular momentum. The hidrogen atom. Perturbations. Formal quantum mechanics. Operator calculus. Commutators, canonical conjugates and uncertainity relations. Harmonic oscillator. Selection rules and spectrum of H. The He atom, the independent particle approximation. The exclusion principle. Periodic system of elements. Molecules. molecular orbitals, chemical bonding, H-H bond. Molecules of many atoms. Orbital hybridisation. Conjugated molecules, cyclic conjugated molecules. Rotation and vibration of molecules. Franck-Condon principle, Rayleigh amp; Raman scattering. Classical and quantum statistics. Solid State Physics: The solid state. Short and long range order. Crystallography. Bonds in crystals. Real and point lattices. Symmetries and unit cells. The reciprocal lattice. Bravais lattices. X- ray diffraction methods. Electrical conductivity. Drudel model. Sommerfeld model. Band theory of solids.Work function. Contact potential. The adiabatic principle. Electrons in periodic lattices. Charge carrier characteristics. Crystal momentum. Effective mass. Band theory. The tight binding model. Intrinsic and doped semiconductors. Semiconductor structures. Superconductivity. Thermal properties. The transport equation. Onsager relations. Quantum theory of lattice vibrations. Optical properties. Magnetic and dielectric properties of solids.

Subject code	Subject name	Requirement	ECTS credit
BMETE14AX15	Physics 1 - Mechanics	Exam	4

Course type	Course code	Course language	Timetable information
Lecture	C0A	English	MON:14:15-16:00
Practice	C1A	English	TUE:14:15-16:00

Subject code	Subject name	Requirement	ECTS credit
BMETE15AX02	Physics A2	Exam	2

Course type	Course code	Course language	Timetable information
Lecture	GA	English	

Properties of electric charges. Insulators and conductors. Coulomb's law. The electric field. Superposition. Electric field lines of forces. The electric flux. Gauss's law. Examples: the electric field of some specific charge distributions. The electric field inside and outside of conducting materials. Work and the electric potential. Capacitance and dielectrics. The electric current in various media. Microscopic interpretation of current density and resistivity. Classical and differential Ohm's law. Resistance and energy dissipation. Resistance and temperature. Low temperature behavior of conductors. Footprints of quantum mechanics: residual resistivity, superconductors, semiconductors. Batteries, electromotive force, internal resistance. Wheatstone bridge. Strain gauge. Magnetic fields. The Lorentz law. Sources of magnetic fields. The non-existence of magnetic monopoles. The Biot-Savart law. Ampere's law. Examples: the magnetic field of some specific current distributions. Forces acting on current carrying conductors. Torque, magnetic moment, spin. Electric motor. The microscopic structure of ferromagnets. Faraday's law of induction. Generators, transformers. Inductance, self-inductance. Energy stored in magnetic fields. Displacement current, generalized Ampere's law. Maxwell's equations of the electromagnetic field. Electromagnetic waves. Properties of radio, infrared, visible, ultraviolet, X-ray and gamma radiation. Thermal radiation. Heat conduction. Heat convection. Infrared camera. Measurement of humidity. Solar cells. Literature: R. A. Serway: Physics for Scientists and Engineers

Subject code	Subject name	Requirement	ECTS credit
BMETE15MF11	Evolutionary Game Theory	Exam	3

Course type	Course code	Course language	Timetable information
Lecture	T0	English	FRI:10:15-12:00

The main goal of this course is to demonstrate the ways how the game theory and evolutionary game theory describe real-life situations affecting human behavior, economics, and biological systems. After a brief survey of the basic concept of the traditional game theory (e.g., games, strategies, Nash equilibrium, etc.) we will study evolutionary games that combine the concepts of game theory with the spirit of Darwinism. We will discuss the decomposition of games and also the potential games related to physical systems. Using simple multi-agent mathematical models we will investigate the effects supporting the maintenance of cooperative behavior in the situations of different social dilemmas (e.g., prisoner's dilemma or public goods game) when the individual interests prefer defection to cooperation. The predictions of the mathematical models will be contrasted with human and animal experiments. Finally we study systems where the evolution is controlled by the competition between different spatial strategy associations.

Subject code	Subject name	Requirement	ECTS credit
BMETE15MF20	Wavelets, Coherent States and Multiresolution Analysis	Exam	3

Course type	Course code	Course language	Timetable information
Lecture	T0	English	TUE:16:15-18:00(F3M01)

The aim of the course is to provide an introduction into the characterization of complex distributions using simply interpretable component functions. Topics to be discussed: Fourier analysis. Time-frequency analysis, window Fourier transformation. Gaacute;bor transformation. Uncertainty principle, Shannonrsquo;s theorem. Continuous wavelet transformation. Coherent states. The Weyl-Heisenberg and the affine group. The generalization of Hilbert

space basis sets: frames. Discrete wavelet transformation. Riesz bases. Multiresolution analysis. The refinement equation. Biorthogonal and orthogonal scaling functions. Compactly supported wavelets: Daubechiesrsquo; construction. Continuity, differentiability, vanishing momenta. Matrix elements of physical operators in wavelet bases.

Subject code	Subject name	Requirement	ECTS credit
BMETE15MF21	Crystalline and Amorphous Material	Exam	3

Course type	Course code	Course language	Timetable information
Lecture	T0	English	TUE:10:15-12:00

1. Introduction 1.1. Historical overview: Science and applications 1.2. Definitions Crystalline, non-crystalline, amorphous, glassy materials, 2. Preparation techniques 2.1. Growth of thin-film forms 2.2. Melt-quenched glasses 2.3. Other techniques 2.4. Phillips constraints theory 3. Structure 3.1. Differences between amorphous and crystalline semiconductors 3.2. Projection from three dimensional structures to one dimensional functions Diffraction measurements 3.2. Three dimensional structure derivation from one dimensional function 3.3. Atomic interactions. Computer simulation methods, Models 3.4. Phase change materials and its application 4. Electronic structure 4.1. Chemical bonds, 4.2. Electronic density of states, 4.3. Defects 4.4. Optical and electronic properties 5. Photo induced phenomena 5.1. Photoinduced volume changes (PVE), photodarkening, photobleaching (PD), 5.2. Photoinduced defect creation (PDC): the Staebler-Wronsky effect, 5.3. In-situ simultaneous measurements of PVE, PD, and PDC 5.4. Photoinduced amorphization or crystallization, 5.5. Some applications of photo-induced effects (solar cells, XEROX, sensors, DVD, etc.)

Subject code	Subject name	Requirement	ECTS credit
BMETE90AX02	Mathematics A2a - Vector Functions	Exam	6

Course type	Course code	Course language	Timetable information
Lecture	EN0-EMK	English	MON:16:15-18:00(K389); MON:16:15-18:00(K389); THU:16:15-18:00(K389); THU:16:15-18:00(K389)
Lecture	EN0-GPK	English	
Practice	EN2-EMK	English	WED:16:15-18:00(K375); WED:16:15-18:00(K375)
Practice	EN1-GPK	English	
Practice	EN1-EMK	English	WED:16:15-18:00(KF88); WED:16:15-18:00(KF88)

Solving systems of linear equations: elementary row operations, Gauss-Jordan- and Gaussian elimination. Homogeneous systems of linear equations. Arithmetic and rank of matrices. Determinant: geometric interpretation, expansion of determinants. Cramer's rule, interpolation, Vandermonde determinant. Linear space, subspace, generating system, basis, orthogonal and orthonormal basis. Linear maps, linear transformations and their matrices. Kernel, image, dimension theorem. Linear transformations and systems of linear equations. Eigenvalues, eigenvectors, similarity, diagonalizability. Infinite series: convergence, divergence, absolute convergence. Sewuences and series of functions, convergence criteria, power series, Taylor series. Fourier series: axpansion, odd and even functions. Functions in several variables: continuity, differential and integral calculus, partial derivatives, Young's theorem. Local and global maxima / minima. Vector-vector functions, their derivatives, Jacobi matrix. Integrals: area and volume integrals.

Subject code	Subject name	Requirement	ECTS credit
BMETE90AX17	Mathematics A2c	Exam	6

Course type	Course code	Course language	Timetable information
Lecture	EN0-CA0	English	TUE:16:15-19:00(CH302); WED:16:15-19:00(CH302)
Practice	EN0-CA1	English	TUE:16:15-19:00(CH302); WED:16:15-19:00(CH302)

Subject code	Subject name	Requirement	ECTS credit
BMETE90AX22	Calculus 2 for Informaticians	Mid-semester mark	6

Course type	Course code	Course language	Timetable information
Lecture	EN0-EB0	English	TUE:10:15-12:00(E407); WED:12:15-14:00(E407)
Practice	EN1-EB1	English	THU:12:15-14:00(E306cd)

Differential equations: Separable d.e., first order linear d.e., higher order linear d.e. of constant coefficients. Series: Tests for convergence of numerical series, power series, Taylor series. Functions of several variables: Limits, continuity. Differentiability, directional derivatives, chain rule. Higher partial derivatives and higher differentials. Extreme value problems. Calculation of double and triple integrals. Transformations of integrals, Jacobi matrix. Analysis of complex functions: Continuity, regularity, Cauchy - Riemann partial differential equations. Elementary functions of complex variable, computation of their values. Complex contour integral. Cauchy - Goursat basic theorem of integrals and its consequences. Integral representation of regular functions and their higher derivatives (Cauchy integral formulae).

Subject code	Subject name	Requirement	ECTS credit
BMETE90AX26	Mathematics A2f - Vector Functions	Mid-semester mark	6

Course type	Course code	Course language	Timetable information
Lecture	EN0-VIK	English	MON:10:15-12:00(E406); WED:08:15-10:00(E406)
Practice	EN1-VIK	English	FRI:12:15-14:00(V1109)

Solving systems of linear equations: elementary row operations, Gauss-Jordan- and Gaussian elimination. Homogeneous systems of linear equations. Arithmetic and rank of matrices. Determinant: geometric interpretation, expansion of determinants. Cramer's rule, interpolation, Vandermonde determinant. Linear space, subspace, generating system, basis, orthogonal and orthonormal basis. Linear maps, linear transformations and their matrices. Kernel, image, dimension theorem. Linear transformations and systems of linear equations. Eigenvalues, eigenvectors, similarity, diagonalizability. Infinite series: convergence, divergence, absolute convergence. Sewuences and series of functions, convergence criteria, power series, Taylor series. Fourier series: axpansion, odd and even functions. Functions in several variables: continuity, differential and integral calculus, partial derivatives, Young's theorem. Local and global maxima / minima. Vector-vector functions, their derivatives, Jacobi matrix. Integrals: area and volume integrals.

Subject code	Subject name	Requirement	ECTS credit
BMETE90AX34	Mathematics EP2	Mid-semester mark	2

Course type	Course code	Course language	Timetable information
Practice	EN1	English	WED:08:15-10:00

Limit, continuity, partial derivatives and differentiability of functions of multiple variables. Equation of the tangent plane. Local extrema of functions of two variables. Gradient and directional derivative. Divergence, rotation. Double and triple integrals and their applications. Polar coordinates. Substitution theorem for double integrals. Curves in the 3D space, tangent line, arc length. Line integral. 3D surfaces. Separable differential equations, first order linear differential equations. Algebraic form of complex numbers. Second order linear differential equations with constant coefficients. Taylor polynomial of exp(x), sin(x), cos(x). Eigenvalues and eigenvectors of matrices.

Subject code	Subject name	Requirement	ECTS credit
BMETE90AX51	Mathematics A4 - Probability Theory	Exam	4

Course type	Course code	Course language	Timetable information
Lecture	EN0-A0	English	TUE:08:15-10:00
Practice	EN1-A1	English	THU:16:15-18:00

Notion of probability. Conditional probability. Independence of events. Discrete random variables and their distributions (discrete uniform distribution, classical problems, combinatorial methods, indicator distribution, binomial distribution, sampling with/without replacement, hypergeometrical distribution, Poisson distribution as limit of binomial distributions, geometric distribution as model of a discrete memoryless waiting time). Continuous random variables and their distributions (uniform distribution on an interval, exponential distribution as model of a continuous memoryless waiting time, standard normal distribution). Parameters of distributions (expected value, median, mode, moments, variance, standard deviation). Two-dimensional distributions. Conditional distributions, independent random variables. Covariance, correlation coefficient. Regression. Transformations of distributions. One- and two-dimensional normal distributions. Laws of large numbers, DeMoivre-Laplace limit theorem, central limit theorem. Some statistical notions. Computer simulation, applications.

Subject code	Subject name	Requirement	ECTS credit
BMETE90MX44	Mathematics M1c - Differential Equations	Exam	3

Course type	Course code	Course language	Timetable information
Lecture	EN-CA0	English	WED:08:15-10:00(H207)
Practice	EN-CA1	English	WED:10:15-12:00(H207)

Preliminaries: one- and multivariate calculus, elements of linear algebra. Explicit first order ordinary differential equations and it solution. Simple types. Linear systems. Higher order equations. Laplace transform, properties and applications. Elements of the qualitative theory. On partial differential equations. Elements of variational calculus.

Subject code	Subject name	Requirement	ECTS credit
BMETE90MX54	Advanced Mathematics for Electrical Engineers - Linear Algebra	Mid-semester mark	3

Course type	Course code	Course language	Timetable information
Lecture	EN0	English	MON:08:15-10:00(QBF11)
Practice	EN1	English	FRI:10:15-12:00(QBF08)

System of linear of equations, Gaussian elimination, vectors, vector spaces, subspaces, basis, matrices, special matrices, LU and PLU decomposition of a matrix, determinants, linear transformations and its properties, computation of the eigenvalues and eigenvectors, euclidean space, orthogonality, diagonalization of a matrix, Jordan canonical form of a matrix, Jordan basis, orthogonal diagonalization, norm of vectors and matrices, singular value decomposition of a matrix, nonnegative matrices, matrix functions, Perron-Frobenius theory. J. Hefferon: Linear

Algebra, 3rd ed.C.D. Meyer: Matrix Analysis and Applied Linear Algebra

Subject code	Subject name	Requirement	ECTS credit
BMETE93AM19	Operations Research	Exam	5

Course type	Course code	Course language	Timetable information
Lecture	A00	English	MON:12:15-14:00(H306)
Practice	A01	English	MON:14:15-16:00(T606)

Introduction to operations research; convex sets, polyhedron, polytope Krein-Milmann theorem. Separation, Farkas' lemma. Linear programming problem, basis, basic solution, optimal solution. Simplex algorithm. Two-phase simplex algorithm, degeneration, index selection rules. Modified simplex algorithm. Sensitivity testing. Weak and strong duality theorem. Network flow problems, algorithms. Network simplex algorithm. Transportation problem, assignment problem, the Hungarian method. Integer programming: Branch and bound method, dynamic programming, cutting plane procedures. Game theory: matrix games.– K. G. Murty, Linear and combinatorial programming, John Wiley and Sons., New York, 1976– V. Chvatal, Linear programming, W.H.Freeman amp; Co Ltd, 1983

Subject code	Subject name	Requirement	ECTS credit
BMETETOP101	Mechanics	Exam	0

Course type	Course code	Course language	Timetable information
Lecture	EN0	English	

Subject code	Subject name	Requirement	ECTS credit
BMETETOP103	Algebra 1	Exam	0

Course type	Course code	Course language	Timetable information
Lecture	A0	English	

Subject code	Subject name	Requirement	ECTS credit
BMETETOP201	Vibration, Waves and Thermodynamics	Exam	0

Course type	Course code	Course language	Timetable information
Lecture	T0	English	
Practice	T1	English	
Practice	T2	English	

Subject code	Subject name	Requirement	ECTS credit
BMETETOP202	Optics and Atomic Physics	Exam	0

Course type	Course code	Course language	Timetable information
Lecture	A0	English	
Practice	A1	English	
Practice	A2	English	

Subject code	Subject name	Requirement	ECTS credit
BMETETOP203	Algebra 2	Exam	0

Course type	Course code	Course language	Timetable information
Lecture	A1	English	

Subject code	Subject name	Requirement	ECTS credit
BMETETOP204	Geometry 2	Exam	0

Course type	Course code	Course language	Timetable information
Lecture	A1	English	

Subject code	Subject name	Requirement	ECTS credit
BMETETOP208	Advanced Algebra	Exam	0

Course type	Course code	Course language	Timetable information
Lecture	A0	English	

Subject code	Subject name	Requirement	ECTS credit
BMETETOPB22	Basic Mathematics 1	Mid-semester mark	0

Course type	Course code	Course language	Timetable information
Lecture	EN0-A0	English	WED:17:15-19:00(K376); WED:17:15-19:00(K376); THU:17:15-19:00(K376); THU:17:15-19:00(K376)

Algebra part. Integers, rational, real numbers. Arithmetic operations and their properties. Prime factorization. Powers. Working with arithmetic expressions. Equations of first degree and second degree. Equations with radicals. Factoring polynomials. Notion of sets. Set operations and their properties. Inequalities. Word problems. Geometry part. Basic notions: lines, angles. Triangles (equilateral, isosceles, right triangles, bisector, altitude, etc. in triangles). Circles. Circumscribed and inscribed circles of triangles. Tangents to circles, angles of circumference. Angles in radian. Perimeter and area of planar figures. Sine, cosine, tangent of angles in right triangles and in triangles with obtuse angle. Sine theorem, Cosine theorem. Parallelograms. Sphere, tetrahedron, prism, cylinder, pyramid, cone, parallelepiped. Surface area and volume. Cartesian coordinate system. Area and volume of similar figures.

Subject code	Subject name	Requirement	ECTS credit
BMETETOPB23	Basic Mathematics 2	Mid-semester mark	0

Course type	Course code	Course language	Timetable information
Lecture	EN0-A0-1	English	TUE:14:15-17:00(K376); TUE:14:15-17:00(K376); FRI:14:15-16:00(K375); FRI:14:15-16:00(K375)

Algebra part. Notion of functions (domain, range, composite function, inverse function), and their representation (graph) in Cartesian coordinate system. Exponential and logarithmic functions. Exponential and logarithmic equations and inequalities. The absolute value function. Equations and inequalities with absolute value. Arithmetic and geometric sequences. Geometry part. Straight lines in Cartesian coordinate system (parallel, perpendicular). Circles and parabolas in Cartesian coordinate system. Sine, cosine, tangent functions and their graphs. Trigonometric equations. Notion of complex numbers, complex arithmetic, rotation. Polar coordinate system. Basics of vector algebra, dot product.

Faculty of Transportation Engineering and Vehicle Engineering

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
BMEKOALM244	City logistics	Exam	5

Course type	Course code	Course language	Timetable information
Lecture	ERA_EA	English	THU:14:15-16:00
Practice	ERA_GYAK	English	THU:16:15-18:00

Subject code	Subject name	Requirement	ECTS credit
BMEKOALM323	Planning of warehousing systems	Exam	5

Course type	Course code	Course language	Timetable information
Lecture	ERA_EA	English	THU:10:15-12:00
Practice	ERA_GYAK	English	THU:12:15-14:00

Subject code	Subject name	Requirement	ECTS credit
BMEKOALM337	Planning of extra-logistics networks	Mid-semester mark	4

Course type	Course code	Course language	Timetable information
Lecture	ERA_EA	English	WED:10:15-12:00
Practice	ERA_GYAK	English	WED:08:15-10:00

Subject code	Subject name	Requirement	ECTS credit
BMEKOKG8517	Financing Transport Infrastructure	Mid-semester mark	4

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

Presentation of theoretical base of transport infrastructure financing and development of skills for practical applications. Financing principles, methods and procedures: Equity Funding, Debt Funding, Private Financing Initiative, PPP for designing, planning, constructing and operating of transport infrastructure. Presentation and application of a software as a decision making tool for preparation of feasibility studies. Risk analysis of financing transport infrastructure. International case studies. The course will consist of 3 hours lessons/week during the 14 weeks (2 hour lecture and 1 hour seminar - where students will be expected to provide brief oral presentations).

Subject code	Subject name	Requirement	ECTS credit
BMEKOKKM222	Road Safety	Mid-semester mark	3

Course type	Course code	Course language	Timetable information
Lecture	ERA_L	English	THU:16:15-18:00
Practice	ERA_P	English	THU:18:15-20:00

Subject code	Subject name	Requirement	ECTS credit
BMEKOKKM230	Environmental effects of transport	Mid-semester mark	4

Course type	Course code	Course language	Timetable information
Lecture	ERA_L	English	TUE:14:15-16:00
Practice	ERA_p	English	TUE:16:15-18:00