University of Debrecen

Centre of Arts, Humanities and Sciences

Hungary

Faculty of Science

Physics, BSc Program

Curriculum

Code	Subject	Lecturer
TMBE0603	Mathematics 1.	Dr. Péter Nagy
TMBE0604	Mathematics 2.	Dr. Péter Nagy
TFBE0301	Introduction to Electronics	Dr. László Oláh
TFBE0601	Introduction to the computer science	Dr. Sándor Sudár
TTBE0030	European Union	Dr. István. Süli-Zakar
TTBE0040	Basic Environmental Science	Dr. Gyula Lakatos
TTBE0020	Quality Management	Dr. Jenõ Borda
TTBE0141	Introduction to chemistry	Dr. Róbert Király
TTBL0141	Introduction to chemistry practicals	Dr. Róbert Király
TFBE0101	Fundamentals of Physics 1. (Mechanics)	Dr. József Pálinkás
TFBG0101	Exercises in Fundamentals of Physics 1. (Mechanics)	Dr. József Pálinkás
TFBE0102	Fundamentals of Physics 2. (Waves and Thermodynamics)	Dr. József Pálinkás
TFBG0102	Exercises in Fundamentals of Physics 2. (Waves and Thermodynamics)	Dr. József Pálinkás
TFBE0103	Fundamentals of Physics 3. (Electromagnetism)	Dr. József Pálinkás
TFBG0103	Exercises in Fundamentals of Physics 3. (Electromagnetism)	Dr. József Pálinkás
TFBE0104	Fundamentals of Physics 4. (Optics, Atomic-, Molecular-, Nuclear- and Particle Physics)	Dr. József Pálinkás
TFBG0104	Exercises in Fundamentals of Physics 4. (Optics, Atomic-, Molecular-, Nuclear- and Particle Physics)	Dr. József Pálinkás
TFBE0401	Solid State Physics	Dr. Dezsõ Beke
TFBE0402	Environmental Physics	Dr. Zoltán Papp
TFBE0302	Digital Electronics	Dr. Gyula Zilizi
TFBL0501	Basic physics laboratory practices in mechanics and thermodynamics I.	Dr. Lajos Daróczi
TFBL0502	Basic physics laboratory practices in mechanics and thermodynamics II.	Dr. Lajos Daróczi
TFBL0503	Measurements in optics 1 (geometrical optics and photometry)	Dr. Zoltán Erdélyi
TFBL0504	Measurements in optics 2 (wave optics, spectroscopy and polarimetry)	Dr. Zoltán Erdélyi
TFBL0505	Laboratory Practicals in Optics and Atomic Physics 1.	Dr. Endre Takács
TFBL0506	Laboratory Practicals in Nuclear Physics 1.	Dr. Péter Raics
TFBL0507	Laboratory Practicals in Electronics 1.	Dr. László Oláh
TFBL0508	Laboratory Practicals in Electronics 2.	Dr. László Oláh
TFBL0510	Practice in Solid State Physics 1.	Dr. Gábor Langer
TFBL0511	Radioactivity measurements	Dr. Zoltán Papp

TFBE0201	Mechanics 1.	Dr. Kornél Sailer
TFBG0201	Mechanics practical 1.	Dr. Kornél Sailer
TFBE0202	Mechanics 2.	Dr. Kornél Sailer
TFBG0202	Mechanics practical 2.	Dr. Kornél Sailer
TFBE0203	Electrodynamics	Dr. Ágnes Vibók
TFBG0203	Electrodynamics practical	Dr. Ágnes Vibók
TFBE0204	Theory of Relativity	Dr. Zsolt Schram
TFBE0205	Quantum Mechanics 1.	Dr. Ágnes Nagy
TFBG0205	Quantum mechanics practical 1.	Dr. Ágnes Nagy
TFBE0206	Thermodynamics and statistical physics	Dr. Ágnes Nagy
TFBE0208	Introduction to electrodynamics	Dr. Ágnes Vibók
TFBE0209	Introduction to quantum mechanics	Dr. Ágnes Nagy
TMBE0605	Mathematics 3.: Linear algebra and group theory	Dr. Nagy Péter
TFBE0606	Applied of probability calculus	Dr. Gyula Pap
TFBE0602	Computer Controlled Measurement and Process Control	Dr. Sándor Sudár
TFBE0303	Analog electronics	Dr. Gyula Zilizi
TFBE0304	Computer Architecture	Dr. Gyula Zilizi
TFBL0604	Computer simulation methods	Dr. Ferenc Kun
TFBE0603	Statistical Data Analysis	Dr. Zoltán Trócsányi
TFBL0602	Laboratory Practical in Computer Controlled Measurement and Process Control	Dr. Sándor Sudár
TFBL0605	Digital signal processing measurements	Dr. István Szabó
TFBL0514	Practice in solid state physics 2.	Dr. Gábor Langer
TFBL0512	Laboratory Practicals in Optics and Atomic Physics 2.	Dr. Endre Takács
TFBL0515	Laboratory practical in nuclear physics 2.	Dr. Sándor Sudár
TFBL0509	Laboratory practicals in electronics 3.	Dr. László Oláh
TFBL0305	Circuit simulation 1.	Dr. Gyula Zilizi
TFBL0306	Circuit simulation 2.	Dr. Gyula Zilizi
TFBL0307	Application of Microcontrollers 1.	Dr. Gyula Zilizi
TFBL0308	Application of Microcontrollers 2.	Dr. Gyula Zilizi
TFBE0403	Atomic and Molecular Physics	Dr. Imre Szalóki
TFBE0404	Nuclear and Particle Physics	Dr. Péter Raics
TFBE0406	Modern Optics	Dr. Péter Raics
TFBE0407	Electron and Atomic Microscopy	Dr. Csaba Cserháti
TFBE0405	Fizikai anyagtudomány	Dr. Beke Dezsõ
TFBE0207	Kvantummechanika 2.	Dr. Nagy Ágnes
TFBE0414	Neutron- and reactor physics	Dr. András Demény
TFBL0517	Laboratory practise on biophysical and biomedical problems	Dr. Sándor Szabó
TFBL0516	Technical Physics	Dr. Sándor Kökényesi
TFBE0408	Materials and Technology	Dr. Gábor Langer

TFBE0411	Materials and technology for microelectronics	Dr. Sándor Kökényesi
TFBE0409	Vacuum Science and Technology	Dr. Gábor Langer
TFBE0412	Analythical spectroscopic methods	Dr Sándor. Kökényesi
TFBE0415	Digital Image Bioengineering	Dr. Csaba Cserháti
TFBE0413	Nuclear measurement techniques	Dr. Zoltán Papp
TFBL0101	Demonstration Laboratory 1. (Mechanics)	Dr. József Pálinkás
TFBL0102	Demonstration Laboratory 2. (Thermodynamics and mechanics)	Dr. József Pálinkás
TFBL0103	Demonstration Laboratory 3. (Electromagnetism)	Dr. Imre Szalóki
TFBL0104	Demonstration Laboratory 4. (Atomic physics)	Dr. Imre Szalóki

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Subject: Mathematics 1
Code: TMBE0603
ECTS Credit Points: 7
Classes/week: 4 hour lecture, 3 hour seminar
Prerequisites: -
Responsible senior lecturer: Péter T. Nagy, DSc.
Lecturer: Péter T. Nagy, DSc.

Topics: Integers, rational numbers, real numbers, complex numbers. Basic combinatorics.. Vector algebra, coordinates, matrices, matrix operations. Determinant and its properties; rank of a matrix; system of linear equations. Sequences of real numbers, convergence. The notion of function, limit, continuity. . Curves and equations. The slope of a curve, the derivative. The derivative of sums, products, quotients. The chain rule, inverse function and its derivative. Elementary functions and their inverses. Fundamental theorems of differential calculus. Extremal values, existence. The main value theorem. Increasing and decreasing functions. Curve sketching. The indefinite integral. Upper and lower sums. Fundamental theorems and basic properties. Inequalities. Improper integrals. Substitution, integration by parts. Applications: length, area and volume. Work and moments. Taylor's formula. Differentiation of vector-valued functions. Differentiable curves. Ordinary differential equations. Linear differential equations, Fundamental solutions, Wronskian and linear independence.

Recommended Readings:

1. Howard, A.: Calculus with analytic geometry, John Wiley and Sons, New York, 1989.
2. Lang, S.: A First Course in Calculus, Springer, 1986.
3. Elliott Mendelson: 3,000 Solved Problems in Calculus, McGraw-Hill, 1988.

Subject: Mathematics 2
Code: TMBE0604
ECTS Credit Points: 5
Classes/week: 2 hour lecture, 3 hour seminar
Prerequisites: Mathematics 1

Responsible senior lecturer: Péter T. Nagy, DSc.
Lecturer: Péter T. Nagy, DSc.

Topics: Functions of several variables, partial derivatives, Jacobian. Differentiability and gradient. Taylor's formula, estimate for the remainder. Critical points, relative maximum and minimum. Stationary point, second derivative test. Multiple integrals, applications: surface area, centers of gravity. Line integrals, independent of paths, Green' theorem. Surface integrals, divergence theorem, Stokes' theorem. Examples for partial differential equations. Discrete probability distributions, continuous density functions. Discrete and continuous conditional probability, paradoxes. Important distributions and densities. Expected value. Discrete and continuous random variables. Law of large numbers. Central limit theorem. Elements of mathematical statistics.

Recommended Readings:

1. Howard, A.: Calculus with analytic geometry, John Wiley and Sons, New York, 1989.
2. Lang, S.: A First Course in Calculus, Springer, 1986.
3. Elliott Mendelson: 3,000 Solved Problems in Calculus, McGraw-Hill, 1988.
4. Feller, W.: An Introduction to Probability Theory and its Applications, John Wiley and Sons, New York, 1950.

Subject: Introduction to Electronics
Code: TFBE0301
ECTS Credit Points: 4
Lecture+practical+lab.practical courses/week: 3+0+0 (36 hours/semester)
Prerequisite: None
Type of exam: Oral/written examination
Responsible senior lecturer: Dr. László Oláh
Lecturers: Dr. László Oláh, Dr. Gyula Zilizi

Aim of the course: The main objective of the course is to study the operation, the characteristics and the applications of basic electronic components
Topics: Passive RC circuits; Characteristics of discrete semiconductors: diodes, bipolar junction transistors, field effect transistors, opto-electronic devices; Simple discrete circuits: amplifiers, oscillators, rectifiers, power supplies; Integrated operational amplifiers: internal circuit, external feedback, basic op-amp circuits; Basic logic circuits, Boolean-algebra, implementation of logic function, combinational (decoders, multiplexers, arithmetical circuits) and sequential (flip-flops, memories, counters) logic circuits; Analog/Digital and Digital/Analog converters; Electronic measuring devices, signal generators, oscilloscopes.

Compulsory/Recommended Readings:

1. U.Tietze – C. Schenk : Analóg és digitális áramkörök, Műszaki könyvkiadó, 1990
2. K. Beuth: Az elektronika alapjai I - II – III, Műszaki könyvkiadó
3. P. Horowitz: The art of electronics, Cambridge University Press, 1989
4. Kovács Csongor: Elektronika, General Press Kiadó
5. Gergely István: Elektrotechnika, General Press Kiadó
6. Kovács Csongor: Digitális elektronika, General Press Kiadó

Subject: Introduction to the computer science
Code: TFBE0601
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: None
Type of exam: Oral exam at the end of the semester
Responsible senior lecturer: Dr. Habil Sándor Sudár
Lecturers: Dr. Habil Sándor Sudár, Dr. Gyula Zilizi , Dr. László Oláh , Zoltán Szillási

Aim of the course: This course provides the basis knowledge in the computer science for further studies in physics and other fields of science and engineering.
Topics: The subject and fundamentals of the information science. Evolution of the computer systems. Structure of the IBM PC. Working modes of the Intel family processors. Bus systems in the IBM PC. Single, multitasking and multi-user operation systems. General features of the multitasking operation systems. Basic features of a UNIX operation system, file system, access rights, programs and processes, command interpreters, basic commands, pipe line, redirection, filters, mailing, connection with other hosts. Local and wide area networks, the Internet. Wireless networks. The qualitative definition of the information, the Shannon Wiener information unit. Noise characteristic of the telecommunication channel, capacity of the channel. Basis of the coding theory, cipher, decipher, the efficiency of coding, unambiguous decoding. Base theorem of the discrete noise free coding.

Compulsory/Recommended Readings:

1. J. L. Hennessy, D. A. Patterson Computer Architecture: A Quantitative Approach, Published by Morgan Kaufmann 2006.
2. J.F. Kurose, K. W. Ross Computer Networking: A Top-down Approach Featuring the Internet - Addison-Wesley- 2003

Subject: European Union
Code: TTBE0030
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 1+0+0
Prerequisite: None
Type of exam: Written examination (Kollokvium)
Responsible senior lecturer: Dr. István Süli-Zakar
Lecturer: Dr. István Süli-Zakar

Aim of the course: The objective of the course is to provide information about the theoretical background of integrations in general, the history of the European Union and its role in the world economy.
Topics: The process of reformation of the integration is going to be shown by the presentment of the institutions of the European Union. The process of enlargement, the characteristics of the fifth phase of the enlargement and the EU membership of Hungary is going to be emphasized especially.

Compulsory/Recommended Readings:

1. Farkas B.-Várnay E.: Bevezetés az Európai Unió tanulmányozásába. – JATE Press Kiadó, Szeged, 1997
2. Palánkai T.: Az európai integráció gazdaságtana. – Aula Kiadó, Budapest, 2001
3. Horváth Z.: Kézikönyv az Európai Unióról. – Akadémiai Kiadó, Budapest, 2005

Subject: Basic Environmental Science
Code: TTBE0040
ECTS Credit Points: 2
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: None
Type of exam: Written examination
Responsible senior lecturer: Dr. Gyula Lakatos
Lecturer: Dr. Gyula Lakatos

Aims of the course: The student should acquire the more important natural science and social science connections of the based on ecology and focused on living organisms. The student have knowledge based on ecology and environmental elements of the environmental sciences. The student should be able to understand the necessity to recognise the sustainable development, knowing the history of environment protection and nature conservation.
Topics: Environmental sciences and the ecological principles. Terminological system of our environment. Environmental sciences and interdisciplinary. Challenge for science. The principle of precaution. Environmental problems. Natural environment. The surface of the Earth. Soil, the hydrosphere, the atmosphere.
The history of the natural conservation and the environmental protection; the sustainable development. Sustainable development. The economics of the human populations and the environmental sources. Limits of the growth. Human demography. The future of human populations. Resources and reserves. The soil as natural resource and the sustainable agriculture. The water supply and the water as power source. Biological resources. The effect of the human activity on the natural environment. The pollution of the atmosphere. Water pollution. The environmental pollution of industry. Technological forecast and the environment. Sustainable development: as a challenge

Compulsory/Recommended Readings:
1. Jackson, A,R.W., Jackson, J.M. 1996: Environmental Science. The natural environment and human impact. Longman, Singapore.
2. Brundtland, G.H. (Chair) 1987: Our common future. Oxford: Oxford University Press.
3. Cunningham, W.P. & Saigo, B.W. 1995: Environmental Science. A global concern. Dubuque: Wm.C. Brown Publishers.

Subject Quality Management
Code: TTBE0020
ECTS Credit Points: 2
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: None
Type of exam: Written examination
Responsible senior lecturer: Dr. Jenő Borda

Lecturers: Dr. János Török and Dr. Jenő Borda

Aim of the course: The aim of the lecture is to provide students a basic knowledge about the quality management and the ISO standards.

Topics: The history of the quality management. The developing of the ISO standard system, advantages. The essence of the TQM and EFQM. The ISO 9000:2000 stanard system; the idea of the quality and quality management, the customer int he centre, respect for the law, the process management and control, the PDCA ring, the continuous developing, the ISO 9004:2000. The presentation of the ISO 9000:2000 standard; the system (handbook, documents), responsibility of the management (quality policy, quality aims, sources of power, communication, revision), production and supply in the ISO, customer service, measurement and control, correction and prevention.

Compulsory/Recommended Readings:

1. ISO 9001:2000 Standard
2. ISO 9004:2000 Standard
3. Quality Management (5th Edition) (Hardcover) by David L. Goetsch, Stanley B. Davis Prentice Hall; 5 edition (June 1, 2005)
4. Quality Management: Introduction to Total Quality Management for Production, Processing, and Services (4th Edition) (Hardcover) by David L. Goetsch, Stanley B. Davis Prentice Hall; 4 edition (April 17, 2002)

Subject: Introduction to chemistry
Code: TTBE0141
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0 (26 hours/semester)
Prerequisite: None
Type of exam: Written examination
Responsible senior lecturer: Dr. Róbert Király
Lecturer: Dr. Róbert Király

The aim of the course is to give a basic knowledge in general and inorganic chemistry for advanced studies.

Topics: Material systems. The states of matter and phase changes. Spontaneous processes. The bases of thermochemistry. General characterization of equilibria. Homogeneous equilibria: Acids and bases, the fundamentals of pH-calculations, redox-equilibria, the formation and characteristics of complexes. Heterogeneous equilibria: The process of dissolution and the properties of solutions, distribution equilibria between two solvents, adsorption of gases and liquids. The bases of kinetics. Basic nuclear chemistry. The structure of atoms: The quantum description and the quantum numbers. The electron structure of atoms and the periodic table of elements. Periodic properties: Ionization energy, electronaffinity and electronegativity, the size of atoms and ions. The types of chemical bonds and their characterization. The occurence and abundance of elements. The most important elements and their compounds of high practical importance.

Compulsory/Recommended Readings:

1. J. McMurry, R. C. Fay, Chemistry, Fourth Edition. Pearson Education International, Inc., Prentice Hall, New Jersey, 2004. ISBN 0-13-121631-7

Subject: Introduction to chemistry practicals
Code: TTBL0141
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+2+0 (26 hours/semester)
Prerequisite: None
Type of exam: Written tests during the semester and practical score
Responsible senior lecturer: Dr. Róbert Király
Lecturers: Dr. Róbert Király and his collegues

The aim of the practicals is to give a possibility to learn the most important fundamental chemical laboratory operations, measurements and calculations.
Topics: The practical part of the course is announced as a block lasting for five weeks and taking about half of the semester. Four times, two seminar hours are given before the practicals. *In the laboratory*, students learn basic laboratory work, including preparation of solutions, calibration of volumetric vessels, recrystallization, titration, extraction and operation with gas-cylinders. Weighing, volumetric measurements and determination of density are also performed. *In seminars*, students learn the fundamental laboratory calculations: Calculation of concentration, titrations, the pH of strong acids and bases.

Compulsory/Recommended Readings:

1. General Chemistry Laboratory. Lab Manual. Supplementary material compiled in the Department of Inorganic and Analytical Chemistry. University of Debrecen, 2004.
2. Villányi A.: How to Get an A in Chemistry (in English) Műszaki Könyvkiadó, Budapest, 2002.

Subject: Fundamentals of Physics 1. (Mechanics)
Code: TFBE0101
ECTS Credit Points: 6
Lecture+practical+lab.practical courses/week: 4+0+0
Prerequisite: None
Type of exam: written and oral exam at the end of the semester, and three written tests during the semester
Responsible senior lecturer: Prof. Dr. József Pálinkás
Lecturers: Dr. András Demény, Prof. Dr. Zoltán Trócsányi

The aim of the course: To introduce the basic concepts and laws of mechanics on the basis of experiments and observation. This course provides the basis for further studies in physics and other fields of science and engineering.
Topics: Physical concepts and quantities; the basic principles of measuring length and time. Frame of reference; path, distance, displacement, velocity, acceleration, angular acceleration. Description of motion in moving frames of reference. Motion of rigid bodies. Law of inertia, inertial frame, the centre of mass. Concepts of mass and momentum, the law of conservation of momentum. Concept of force, force laws. Newton's laws, the fundamental law of dynamics. Solutions of the equation of motion for simple cases: motion in homogeneous gravitational field, oscillations. Constrained motion, friction. Equation of motion of rockets,

current of momentum and mass. Galilei's principle. Motion in accelerating frames of reference. Angular momentum, torque. Angular momentum theorem. Angular momentum of a system of particles, orbital angular momentum and spin. Rotation of rigid bodies around fixed axis. Motion of rigid bodies in a plane, rolling. Balance of rigid bodies. Motion of tops. Collisions. Concepts of work and kinetic energy, the work-energy theorem for pointlike and extended rigid objects. Potential energy of spring and gravitational interaction. Conservation of mechanical energy. Statics of elastic bodies. Elastic strength, Hooke's law. Shearing and torsion. Statics of liquids and gases, pressure. Pascal's laws, hydrostatic pressure. Law of Archimedes. The Boyle–Mariotte law; air pressure. Concepts of fluid mechanics. Continuity equation. Bernoulli's equation and its applications. Friction of fluids: Newton's law of viscosity. Laminar stream in pipes. Turbulence, drag.

<u>Compulsory/Recommended Readings:</u>
- D. Halliday, R. Resnick, J. Krane: Physics Vol. I., John Wiley & Sons Inc.
- Sears, Zemansky, Young: University Physics, Addison-Wesley Publishing Company
- D. Halliday, R. Resnick and J. Krane: Fundamentals of Physics, John Wiley & Sons Inc.

Subject: Exercises in Fundamentals of Physics 1. (Mechanics)
Code: TFBG0101
ECTS Credit Points: 2
Lecture+practical+lab.practical courses/week: 0+2+0
Prerequisite: TFBE0101 in parallel
Type of exam: two written tests during the semester
Responsible senior lecturer: Prof. Dr. József Pálinkás
Lecturers: Dr. Ferenc Cserpák, Dr. András Demény, Dr. Judit Darai, Márta Sántháné Koczka

The aim of the course: To facilitate a deeper understanding of concepts and laws of mechanics, help the students acquire the basics skills in solving problems.
Topics: The topics of exercise sessions follow that of the course encoded TFBE0101.

<u>Compulsory/Recommended Readings:</u>
1. D. Halliday, R. Resnick, J. Krane: Physics Vol. I., John Wiley & Sons Inc.
2. Sears, Zemansky, Young: University Physics, Addison-Wesley Publishing Company
3. D. Halliday, R. Resnick and J. Krane: Fundamentals of Physics, John Wiley & Sons Inc.

Subject: Fundamentals of Physics 2. (Waves and Thermodynamics)
Code: TFBE0102
ECTS Credit Points: 6
Lecture+practical+lab.practical courses/week: 4+0+0
Prerequisite: TFB0101, TFG0101, TMBE0603
Type of exam: written and oral exam at the end of the semester, and three written tests during the semester
Responsible senior lecturer: Prof. Dr. József Pálinkás
Lecturers: Dr. András Demény, Prof. Dr. Zoltán Trócsányi

The aim of the course: To introduce the basic concepts and laws of wave motion, geometrical optics, special relativity thermodynamics and statistical mechanics on the basis of experiments and observation. This course provides the basis for further studies in physics and other fields of science and engineering.
Topics: : Elastic waves, speed of propagation, energy transport, interference. Wave function and energy of harmonic waves. Standing waves. Interference, reflection, refraction of multidimensional waves. Huygens's principle and the Huygens–Fresnel principle. Doppler's effects. Acoustic sensation. Light waves. Speed of light. Geometrical optics; mirrors, lenses. Optical devices. Michelson's experiment. Principle of special relativity. Lorentz-transformations their kinematical consequences; experimental evidences. Relativistic mass and moment. Newton's second law in relativistic form. Relativistic theorem of work, mess-energy equivalence, mass defect.
Concept of thermal equilibrium, the empirical thermal scales. Gay-Lussac's law, the ideal gas scale. State functions, equations of states. Internal energy, the 1st law of thermodynamics. Experiences in measuring specific heat, Dulong–Petit law. Enthalpy, specific heats of gases. Internal energy of gases; free expansion, Joule–Thompson experiment. Reversible and irreversible processes. Heat engines and refrigerators. Carnot-cycle. Perfect engine; phenomenological formulation of the 2nd law of the thermodynamics. The thermodynamic temperature scale. Molecular structure of matter; Dalton's and Avogadro's laws, Brownian motion. Surface tension, capillarity. Kinetic model of gases. Interpretation of pressure and temperature of ideal gases. Law of equipartition. Freezing and melting of degrees of freedom. Concept of probability distribution; Maxwell distribution of speeds. Stern's experiment. Energy distribution of oscillators. Oscillators of quantised energy. Microscopic and macroscopic states. Interpretation of statistical temperature and entropy, statistical formulation of the 2nd law. Thermodynamic entropy, free energy and free enthalpy. Phase transitions, phase equilibrium; phase diagram. Chemical potential, Clausius–Clapeyron equation. Liquid–vapour isotherms, condensation of gases. Multi component systems. Mixtures of ideas gases, configuration entropy, diluted solutions. Transport phenomena: diffusion, heat conduction, viscosity.

Compulsory/Recommended Readings:

I. D. Halliday, R. Resnick, J. Krane: Physics Vol. I., John Wiley & Sons Inc.
II. Sears, Zemansky, Young: University Physics, Addison-Wesley Publishing Company
III. D. Halliday, R. Resnick and J. Krane: Fundamentals of Physics, John Wiley & Sons Inc.

Subject: Exercises in Fundamentals of Physics 2. (Waves and Thermodynamics)
Code: TFBG0102
ECTS Credit Points: 2
Lecture+practical+lab.practical courses/week: 0+2+0
Prerequisite: TFBE0102 in parallel
Type of exam: two written tests during the semester
Responsible senior lecturer: Prof. Dr. József Pálinkás
Lecturers: Dr. Ferenc Cserpák, Dr. András Demény, Dr. Judit Darai, Márta Sánthané Koczka

The aim of the course: To facilitate a deeper understanding of concepts and laws of wave motion, geometrical optics, special relativity, thermodynamics and statistical mechanics, help the students acquire the basics skills in solving problems.
Topics: The topics of exercise sessions follow that of the course encoded TFBE0102.

Compulsory/Recommended Readings:

1. D. Halliday, R. Resnick, J. Krane: Physics Vol. I., John Wiley & Sons Inc.
2. Sears, Zemansky, Young: University Physics, Addison-Wesley Publishing Company
3. D. Halliday, R. Resnick and J. Krane: Fundamentals of Physics, John Wiley & Sons Inc.

Subject: Fundamentals of Physics 3. (Electromagnetism)
Code: TFBE0103
ECTS Credit Points: 6
Lecture+practical+lab.practical courses/week: 4+0+0
Prerequisite: TFBE0102
Type of exam: oral exam at the end of the semester, and two written tests during the semester
Responsible senior lecturer: Prof. Dr. József Pálinkás
Lecturers: Dr. József Pálinkás, Dr. Sándor Sudár, Dr. Imre Szalóki, Dr. Ferenc Cserpák, Dr. Endre Takács
The aim of the course: To introduce the basic concepts and laws of electromagnetism on the basis of experiments and observation. This course provides the basis for further studies in physics and other fields of science and engineering.
Topics: Basic concepts and phenomena of electrostatics. Electric charge, force between charges. Coulomb's law. Electric charge and matter. Millikan's experiment. The concept of electric field. Gauss's law. The basic characteristics of the static electric field: Electrostatic potential. The electric dipole moment, the electric field of a system of charges, the principle of superposition. Conductors and insulators. The distribution of electric charge on an isolated conductor, corona discharge. Capacitance and capacitors. Energy density of the electrostatic field. Dielectrics, electric polarization, susceptibility, displacement vector. Electric current and electric resistance, current density. Resistivity and conductivity. Ohm's law and Joule's law. The microscopic view of the electronic conduction in solids. Electronic circuits, the electromotive force. Kirchhoff's rules, an RC circuit. The mechanism of the electronic conduction of liquids and gases. The concept of the magnetic field and the definition of magnetic field inductance vector. Magnetic force acting on a current or a moving charge. The magnetic field induced by a current or a moving charge Biot–Savart's and Amper's law. Magnetic properties of matter. Dia-, para- és ferromagnetic materials. An atomic view of the magnetism of matter, the Einstein de Haas experiment. Motion of charged particles in electric and magnetic field. The charge to mass ration of the electron, the J. J. Thompson's experiment. Mass spectrometers and particle accelerators. The Hall effect. Faradays law of induction. Lenz's rule. The properties of the induced electric field. Self induction. RL circuits, mutual induction. Energy stored in the magnetic field. Electromagnetic oscillations. Free and damped oscillations in LC and RLC circuits, forced oscillations, coupled oscillations, resonance. Alternating current circuits. Motors and generators, the transformer. The three phase alternating current. The concept of displacement current and induced magnetic field. The Ampere-Maxwell law. Maxwell's equations in differential and integral forms. Potentials

and the wave equation. Electromagnetic waves. Dipole radiation, electromagnetic plane waves. Energy and momentum in the electromagnetic radiation

Compulsory/Recommended Readings:

1. D. Halliday, R. Resnick, J. Krane: Physics Vol. II., John Wiley & Sons Inc.
2. Sears, Zemansky, Young: University Physics, Addison-Wesley Publishing Company
3. D. Halliday, R. Resnick and J. Krane: Fundamentals of Physics, John Wiley & Sons Inc.

Subject: Exercises in Fundamentals of Physics 3. (Electromagnetism)
Code: TFBG0103
ECTS Credit Points: 2
Lecture+practical+lab.practical courses/week: 0+2+0
Prerequisite: TFBE0103 in parallel
Type of exam: two written tests during the semester
Responsible senior lecturer: Prof. Dr. József Pálinkás
Lecturers: Dr. József Pálinkás, Dr. Sándor Sudár, Dr. Imre Szalóki, Dr. Ferenc Cserpák, Dr. Endre Takács

The aim of the course: To facilitate a deeper understanding of concepts and laws of electricity and magnetism, help the students acquire the basics skills in solving problems.
Topics: The topics of exercise sessions follow that of the course encoded TFBE0103.

Compulsory/Recommended Readings:

D. Halliday, R. Resnick, J. Krane: Physics Vol. II., John Wiley & Sons Inc.
Sears, Zemansky, Young: University Physics, Addison-Wesley Publishing Company
D. Halliday, R. Resnick and J. Krane: Fundamentals of Physics, John Wiley & Sons Inc.

Subject: Fundamentals of Physics 4. (Optics, Atomic-, Molecular-, Nuclear- and Particle Physics)
Code: TFBE0104
ECTS Credit Points: 6
Lecture+practical+lab.practical courses/week: 4+0+0
Prerequisite: TFBE0103
Type of exam: oral exam at the end of the semester, and two written tests during the semester
Responsible senior lecturer: Prof. Dr. József Pálinkás
Lecturers: Dr. József Pálinkás, Dr. Sándor Sudár, Dr. Imre Szalóki, Dr. Ferenc Cserpák, Dr. Endre Takács

The aim of the course: To introduce the basic concepts and laws of light as electromagnetic wave, and to introduce the experiments and phenomena, which paved the way to the concept of quantummechanics. To explain – on the basis of the classical quantummechanics – the fundamental experiments and phenomena of atomic and molecular physics, the properties of solid materials and the atomic nuclei. The introduction of the basic concepts of particle physics and cosmology are also given. This course provides the basis for further studies in physics and other fields of science and engineering.

Topics: The properties and propogation of light, the Huygens–Fresnel principle, emission and absorption of light. The light as an electromagnetic wave. Energy and momentum in the light wave. The speed of light. Interference. The Young's two slit experiment. Interference in thin films. The diffraction of light on a slit, on double slits and on optical gratings. Diffraction on circular apertures, Fresnel zones. The angular resolution of optical equipments. The propogation of light in materials, absorption and scattering. Polarization and double refraction. The properties of thermal radiation, Planck's law, the photoelectric effect, the concept of the photon. The Compton effect and the spectral lines of atoms. The wave properties of material particles, the de Broglie wavelength. Material waves. The Heisenberg uncertainty principle. The Schrödinger equation, the quantum sates of simple systems. The principle of correspondence and complementarity. The structure of the atom. The Thompson model. The Rutherford experiment. The Bohr/Rutherford model of the atom. The Frank Hertz experiment. The simple quantummechanical model of the Hydrogen atom. The quantum numbers. The spin of the electron. The Stern Gerlach experiment. The characteristic x radiation. The Pauli principle and the structure of many electron atoms. Spontaneous and induced emission light, and the laser effect. Chemical bonds. The electronic properties of solids, band structure and quantum statistics. Contact and thermoelectric phenomena. Electric current in semiconductors, diodes and transistors, light emitting diodes. Superconductivity. The discovery of the atomic nucleus. Radioactivity. The effect and measurement of radioactive radiation. Cosmic rays. The properties and structure of the atomic nuclei. Nuclear models. Nuclear fission and fusion. Energy from the nuclei, nuclear reactors. Elementary particles and fundamental interactions. The basic principles of cosmology.

<u>Compulsory/Recommended Readings:</u>

1. D. Halliday, R. Resnick, J. Krane: Physics Vol. II., John Wiley & Sons Inc.
2. Sears, Zemansky, Young: University Physics, Addison-Wesley Publishing Company
3. D. Halliday, R. Resnick and J. Krane: Fundamentals of Physics, John Wiley & Sons Inc.
4. R. Eisberg and R. Resnick: Quantum Physics, Second Edition, John Wiley & Sons Inc

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Subject: Exercises in Fundamentals of Physics 4. (Optics, Atomic-, Molecular-, Nuclear- and Particle Physics)
Code: TFBG0104
ECTS Credit Points: 2
Lecture+practical+lab.practical courses/week: 0+2+0
Prerequisite: TFBE0104 in parallel
Type of exam: two written tests during the semester
Responsible senior lecturer: Prof. Dr. József Pálinkás
Lecturers: Dr. József Pálinkás, Dr. Sándor Sudár, Dr. Imre Szalóki, Dr. Ferenc Cserpák, Dr. Endre Takács

The aim of the course: To facilitate a deeper understanding of concepts and laws of optics, atomic and quantum physics, help the students acquire the basics skills in solving problems.
Topics: The topics of exercise sessions follow that of the course encoded TFBE0104.

<u>Compulsory/Recommended Readings:</u>

D. Halliday, R. Resnick, J. Krane: Physics Vol. II., John Wiley & Sons Inc.
Sears, Zemansky, Young: University Physics, Addison-Wesley Publishing Company

D. Halliday, R. Resnick and J. Krane: Fundamentals of Physics, John Wiley & Sons Inc.
R. Eisberg and R. Resnick: Quantum Physics, Second Edition, John Wiley & Sons Inc

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Subject: Solid State Physics
Code: TFBE0401
ECTS Credit Points: 4
Lecture+practical+lab.practical courses/week: 3+0+0
Prerequisite: TFBE0104
Type of exam: oral exam at the end of the semester
Responsible senior lecturer: Prof. Dr. Dezső Beke
Lecturers: Dr. Dezső Beke, Dr. Zoltán Erdélyi

The aim of the course: To introduce the basic concepts and laws of experimental solid state physics and provide solid knowledge for further studies in solid state physics and materials science.
Topics: Crystal structure. Bravais lattices, Miller indices. Crystal Binding. Periodic functions in crystal lattice. Reciprocal lattice. Bloch theorem. Cyclical boundary conditions. Interaction between an electromagnetic waves and the crystal lattice. Methods of diffraction. Plastic behaviour, dislocations. Lattice vibrations. Phonons, inelastic neutron diffraction, infrared absorption. Specific heat. Heat conduction. Dielectric properties. Free electron model. Feynmann-model. Kronig-Penney model. Effective mass. Electron scattering, electric resistivity. Thermoelectric properties. Superconductivity. Dia- and paramagnetism. Ferromagnetism (Curie-Weiss-law, Heisenberg exchange interaction). Optical properties, colour centers. Point defects and diffusion.

Compulsory/Recommended Readings:

1. C. Kittel: “Introduction to Solid State Physics” 5th edition, John and Wiley & Sons inc. New York. 1979
2. A.G. Guy: „Introduction to Materials Science” McGraw-Hill Book Company, New York, 1976
3. R. Cahn and P. Hasen, “Physical Metallurgy” 4th edition, North-Holland, Amsterdam, 1996

Subject: Environmental Physics
Code: TFBE0402
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: TFBE0102, TTBE0040
Type of exam: written examination
Responsible senior lecturer: Dr. Zoltán Papp
Lecturer: Dr. Zoltán Papp

Aim of the course: To give an introduction into the ideas, fundamental knowledge and way of thinking of environmental physics.
Topics The concept of environmental physics. The place and role of environmental physics in the system of sciences. Environment as a part of the Universe in space and time. Physical effects of cosmic origin in the environment (effect of extragalactic and galactic origin, effects

of Sun, Moon and other objects inside the Solar System). Physical effects of earthly origin in the environment (Earth's origin, Earth's inner structure, Earth's internal heat, Earth's revolution and rotation, Earth's gravitational and magnetic fields). Physics of the Earth's crust (wandering of continents, global plate tectonics, formation of mountains, volcanism, earthquakes, erosion, physical properties of rocks and soil). Physics of the natural waters (physical properties of water, water in the environment, environmental circulation of water and transportation of energy with water, physics of oceans, seas, rivers, lakes, groundwater and ice). Physics of the atmosphere (it's vertical and horizontal structure, the energy balance of the earth-atmosphere system, greenhouse-effect, ozone-shielding, fundamentals of the weather phenomena, electricity and optics in the atmosphere, transport of matter through the atmosphere, aerosols, climate system, climate change).

Compulsory/Recommended Readings:

1. E. Boeker – R. van Grondelle: Environmental Physics, John Wiley & Sons, Chichester,
   1995.
2. J.L. Monteith – M. Unsworth: Principles of Environmental Physics, Edward Arnold,
   London, 1990.
3. M. L. Salby: Fundamentals of Atmospheric Physics, Academic Press, San Diego, 1996.
4. W. J. Burroughs: Climate Change. A multidisciplinary approach. Cambridge University Press, Cambridge, 2001
5. Papers from journals Scientific American, New Scientist, and Physics Today etc.

Subject: Digital Electronics
Code: TFBE0302
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: TFBE0301
Type of exam: written and oral examination
Responsible lecturer: Dr. Gyula Zilizi
Lecturers: Dr. Gyula Zilizi, Dr. László Oláh

Topics: Logic states and functions, logic identities. Gates and truth tables. Discrete and IC gate circuits (TTL, CMOS, NMOS). Interfacing between logic families. Combinational logic circuits: multiplexers, encoders, decoders, binary adders, PAL and PLA circuits. Sequential logic circuits: memories, counters, shift registers, serial-parallel converters. A/D and D/A converters. Driving external loads and optoelectronic displays. Digital interconnections, driving cables, serial and parellel standards. DC and noise problems in digital circuits

Compulsory/Recommended Readings:

1. Paul Horowitz, Winfield Hill: The Art of Electronics (Cambridge University Press, Cambridge, USA, 1993)

Subject: Basic physics laboratory practices in mechanics and thermodynamics I.

Code: TFBL0501
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1 (4x4h/semester)
Prerequisite: TFBE0101
Type of exam: practical mark
Responsible lecturer: Dr. Lajos Daróczi
Lecturers: Dr. Gábor Langer, Dr. Csaba Cserháti, Dr. Lajos Daróczi, Dr. Zoltán Erdélyi

The aim of the course: Development of fundamental skills for experimental work. Introducing students to the practical measurement and data evaluation methods.
Topics: Measurement basic quantities: length, mass, density. Measurement of gravitational acceleration with different pendulum-methods. Measurement modulus of elasticity under uniaxial stress. Elastic bending of beams. Measurement of inertia moment and shear modulus, torsion deformation.

Compulsory/Recommended Readings:

1. John J. O'Dwyer: College physics second edition, Wadsworth Publishing Company 1984
2. Willems, Easley, Rolfe: Strength of materials, McGraw-Hill 1981
3. Physics demonstration experiments, Edited by H.F. Meiners, The Ronald Press Company 1970
4. Alonso Finn: Physics, Oldenburg 2000
5. Young & Freedman: University Physics, Addison Wesley 2000
6. Serway: Physics for Scientists and Engineers with Modern Physics

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Subject: Basic physics laboratory practices in mechanics and thermodynamics II.
Code: TFBL0502
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1 (4x4h/semester)
Prerequisite: TFBE0101
Type of exam: practical mark
Responsible lecturer: Dr. Lajos Daróczi
Lecturers: Dr. Gábor Langer, Dr. Csaba Cserháti, Dr. Lajos Daróczi, Dr. Zoltán Erdélyi

The aim of the course: Development of fundamental skills for experimental work. Introducing students to the practical measurement and data evaluation methods.
Topics: Measurement of internal friction in liquids and solids. Measurement of velocity of sound in air and in solids. Measurement of surface tension. Temperature measurements (calibration of thermocouples and thermistors), Measurement of thermal expansion and heat conductivity coefficients. Measurement of specific heat. Measurement of heat of phase transformations. Measurement of humidity of air.

Compulsory/Recommended Readings:

1. John J. O'Dwyer: College physics second edition, Wadsworth Publishing Company 1984

2. Physics demonstration experiments, Edited by H.F. Meiners, The Ronald Press Company 1970
3. Alonso Finn: Physics, Oldenburg 2000
4. Young & Freedman: University Physics, Addison Wesley 2000
5. Serway: Physics for Scientists and Engineers with Modern Physics
6. De Hoff: Thermodynamics in Materials, Wiley 2005

Subject: Measurements in optics 1 (geometrical optics and photometry)
Code: TFBL0503
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1
Prerequisite: TFBE0103
Type of exam: practical mark
Responsible lecturer: Dr. Erdélyi, Zoltán
Lecturers: Dr. Erdélyi, Zoltán; Dr. Langer, Gábor; Dr. Szabó, Sándor; Dr. Beszeda, Imre; Dr. Daróczi, Lajos

The aim of the course: Experiments are a main part of physics. They provide information to clear up and understand better the relationships. Moreover, also the experiments may prove the validity of theoretical results. The aim of these base level laboratory exercises is to get acquainted with basic experimental methods, equipments, and to comprehend better the laws of geometrical optics and photometry shown in the lectures. Further goal is to treat the measured results adequately and to calculate the measuring error.
Topics: Measurement of focal length of lens: measurement of the focal length of a thin focusing and a defocusing lens in different manner (e.g. based on the lens law, Bessel's method, graphical method), determination of the distance of the principle planes of a thick lens. Measurement of lens errors: determination of some errors of a thin lens (spherical aberration, curvature of image field, astigmatism, coma, field distortion). Study of telescopes and microscopes: measurement of the magnification and the angle of aspect of a telescope; determination of the magnification, the focal length of one of the objectives and the total magnification of a microscope; moreover the measurement of the size of an object by the microscope. Photometry: determination of the calibration curve, then measurement of the intensity of illumination of a bulb (also the angle distribution) and the reflection of a screen (also the angle distribution). Measurements by a Pulfrich type photometer: determination of the absorption spectrum, the absorbance and the concentration of coloured liquids; measurement of the sensitometric curve of illuminated films.

<u>Compulsory/Recommended Readings:</u>
1. HyperPhysics (C.R. Nave, Georgia State University): http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
2. Budó Ágoston, Mátrai Tibor: Kísérleti fizika III
3. Csordás László, Patkó József, Horvai Rezső, Zsoldos Lehel: Fizikai laboratóriumi gyakorlatok I.
4. Szalay Sándor: Fizikai gyakorlatok I.
5. Kiss Sándor, Kedves Ferenc: Kiegészítő jegyzet optika laboratóriumi gyakorlatokhoz

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Subject: Measurements in optics 2 (wave optics, spectroscopy and polarimetry)

Code: TFBL0504
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1
Prerequisite: TFBE0103
Type of exam: practical mark
Responsible lecturer: Dr. Erdélyi, Zoltán
Lecturers: Dr. Erdélyi, Zoltán; Dr. Langer, Gábor; Dr. Szabó, Sándor; Dr. Beszeda, Imre; Dr. Daróczi, Lajos

The aim of the course: Experiments are a main part of physics. They provide information to clear up and understand better the relationships. Moreover, also the experiments may prove the validity of theoretical results. The aim of these base level laboratory exercises is to get acquainted with basic experimental methods, equipments, and to comprehend better the laws of geometrical optics and photometry shown in the lectures. Further goal is to treat the measured results adequately and to calculate the measuring error.
Topics: Wavelength measurement of light on using an aperture: determination of the wavelength of spectral lines on the basis of diffraction at an aperture. Wavelength measurement by optical grate: determination of the lattice constant of an optical grate on using a light source with known wavelength (laser); moreover knowing already the lattice constant, measurement of the wavelength of some spectral lines of some light sources (spectral lamps). Spectroscopy: calibration of the spectroscope, determination of emission and absorption spectra by a conventional prism and a direct vision spectroscope. Polarimetry: determination of the rotatory direction, the rotatory power and the concentration of optically active solutions. Investigation of refractive index and dispersion: determination of the refractive index and the dispersion of some liquids (concentration and temperature dependence) by Abbe type refractometer, moreover the measurement of the refractive index of a prism by a goniometer.

<u>Compulsory/Recommended Readings:</u>

1. HyperPhysics (C.R. Nave, Georgia State University): http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
2. Budó Ágoston, Mátrai Tibor: Kísérleti fizika III
3. Csordás László, Patkó József, Horvai Rezső, Zsoldos Lehel: Fizikai laboratóriumi gyakorlatok I.
4. Szalay Sándor: Fizikai gyakorlatok I.
5. Kiss Sándor, Kedves Ferenc: Kiegészítő jegyzet optika laboratóriumi gyakorlatokhoz

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Subject: : **Laboratory Practicals in Optics and Atomic Physics**
Code: TFBL0505
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1 (4x4h/semester)
Prerequisite: TFBE0103
Type of exam: practical mark
Responsible lecturer: Dr. Endre Takács
Lecturers: Dr. József Szabó; Dr. Péter Raics

Topics: Determination of the h/e ratio, direct determination of the Boltzmann constant, experimental demonstration of the Stefan-Boltzmann law (2 x 4 hours)

Compulsory/Recommended Readings:

1. Szabó J., Raics P.: Atomfizikai és optikai laboratóriumi gyakorlatok KLTE 1986

Subject: : Laboratory Practicals in Nuclear Physics 1.
Code: TFBL0506
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1 (16 hours/semester)
Prerequisite: TFBE0404
Type of exam: practical mark
Responsible lecturer: Dr. Péter Raics
Lecturers: Dr. Péter Raics; Dr. Magdolna Váradi

Aim of the course: The objective of the course is to teach advanced experimental skills in radioactivity and basic nuclear physics and to study devices as well as measurement techniques.
Topics: Determination of the elementary charge by Millikan-method. Measurements with Geiger-Mueller tubes: determination of counting plateau, time resolution, investigation of the time distribution of pulses. Gamma-spectrometry with scintillation counters. Utilization of semiconducter detectors for gamma-spectrometry. Determination of the characteristic X-ray energies: verification of the Moseley-law. Alpha-spectrometry with semiconductor detectors – measurement of specific energy loss. Investigation of Rutherford-scattering.

Compulsory/Recommended Readings:

1. Angeli I., Csikai Gy., Nagy S., Pázsit Á., Váradi M.: Fizikai gyakorlatok, Atommag labor. (egyetemi jegyzet Debrecen, 1973), http://fizika.ttk.unideb.hu/kisfiz/okts.html: Jegyzetek, Váradi M.: Magfizika I. és II. lab.gyakorlati jegyzetek.
2. Raics P.: Atommag- és részecskefizika. Jegyzet. (DE Kísérleti Fizikai Tanszék, 2002.) http://fizika.ttk.unideb.hu/kisfiz/Raics
3. Raics P.—Sükösd Cs.: Atommag- és részecskefizika, „A fizika alapjai”, VI. rész, 635-714 (Nemzeti Tankönyvkiadó, Budapest, 2003.)
4. Sükösd Cs.: Atommagfizika. VII. rész, „Fizika III.” 329-482 (szerk. Erostyák J., Litz J., Nemzeti Tankönyvkiadó, Budapest, 2006.)
5. Fényes T. (szerk.): Atommagfizika. (Debreceni Egyetem, Kossuth Egyetemi Kiadó, 2005.)
6. R.Eisberg, R.Resnick: Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles (2nd ed. J.Wiley, New York, 1985.)
7. K.Heyde: Basic Ideas and Concepts in Nuclear Physics. (IOP Publishing Co, Bristol, 1994.)
8. R.Bigelow, M.Moloney, J.Philpott, J.Rothberg: Nuclear and Particle Physics Simulations. (CUPS, J.Wiley, New York, 1995.)
9. D.Halliday, R.Resnick, J.Walker: Fundamentals of Physics, Part 5. (J.Wiley, New York, 1997.)

Subject: : Laboratory Practicals in Electronics 1.
Code: TFBL0507

ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1 (16 hours/semester)
Prerequisite: TFBE0103, TFBE0301
Type of exam: practical mark
Responsible lecturer: Dr. László Oláh
Lecturers: Dr. László Oláh; Dr. Gyula Zilizi

Aim of the course: The objective of the course is to teach basic experimental skills in electronic measurements and to study basic (LC, power supply, bridge) circuits.
Topics: Frequency resonance measurements on LC circuits. Determination of resistance by Wheatstone bridge. Measurements on power supply circuits. Determination of the dependence of salt solution conductivity.

Compulsory/Recommended Readings:
1. Sztaricskai T.: Fizikai gyakorlatok; Elektromos labor KLTE, 1991

Subject: : Laboratory Practicals in Electronics 2.
Code: TFBL0508
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1 (16 hours/semester)
Prerequisite: TFBE0103, TFBE0301
Type of exam: practical mark
Responsible lecturer: Dr. László Oláh
Lecturers: Dr. László Oláh; Dr. Gyula Zilizi

Aim of the course: The objective of the course is to teach advanced experimental skills in electronic measurements and to study basic digital and op-amp circuits.
Topics: Analog electronics: Specification of operational amplifiers, basic op-amp circuits: inverting, non-inverting, summing and differential amplifiers, voltage-current converters, integrator, differentiator, oscillator circuit.Digital electronics: Logic gates; basic combinational logic circuits: encoders, decoders, binary adders; basic sequential logic circuits: memories, counters, shift registers, serial-parallel converter.

Compulsory/Recommended Readings:
1. Oláh László: Analóg elektronika laboratóriumi gyakorlatok (KLTE, TTK, Kísérleti Fizikai Tanszék, tanszéki jegyzet, 1996)
2. Sztaricskai Tibor, Vas László: Elektronikus laboratóriumi mérések (KLTE, TTK, Kísérleti Fizikai Tanszék, tanszéki jegyzet, 1973)

Subject: Practice in Solid State Physics 1.
Code: TFBL0510
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1
Prerequisite: None
Type of exam: two written tests during the semester
Responsible lecturer: Dr. Gábor Langer

Lecturers: Dr. Csaba Cserháti, Dr. Lajos Daróczi, Dr. Gábor Erdélyi, Dr. Szabó Sándor, Harasztosi Lajos

The aim the course: To facilitate a deeper understanding of basic concepts and laws of solid state physics.

Description of the topics of the course: Temperature dependence of magnetization, measurement of coercivity and hysteresis. Inspection of hardness and tensile strength. Basic concepts of differential scanning analysis. Temperature dependence of resistivity. Measurement of diffusion in liquids. Measurement of Barkhausen noise.

<u>Compulsory/Recommended Readings:</u>

1. 1. D. Halliday, R. Resnick and J. Krane: Fundamentals of Physics, John Wiley & Sons Inc.
2. Milton Ohring, The Materials Science of Thin Films, Academic Press, Inc. Boston

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Subject: Radioactivity measurements
Code: TFBL0511
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1 1 (16 hours/semester)
Prerequisite: TFBE0104
Type of exam: two practical mark
Responsible lecturer: Dr. Zoltán Papp
Lecturers: Dr. Zoltán Papp, Dr. Zoltán Dezső, Dr. Eszter Baradács Erdélyiné

The aim of the course: To teach advanced experimental skills in radioactivity measurements and to study basic properties of alpha- and beta-radiations.
Topics: (1) Determination of the range in air and energy of alpha-particles varying air pressure in a vacuum-chamber and using a CCD-detector. (2) Investigation of the self-absorption of beta-particles using end-window Geiger-Müller counter. (3) Investigation of the backscattering of beta-particles using end-window Geiger-Müller counter. (4) Determination of the range and energy of beta-particles from the measurement of beta-absorption curve.

<u>Compulsory/Recommended Readings:</u>

1. E. Bleuler – G. J. Goldsmith: Experimental nucleonics, Rinehart & Company, Inc., New York, 1952.
2. NCRP: A handbook of radioactivity measurements procedures, National Council on radiation protection and measurements, Bethesda, 1994.
3. G. F. Knoll: Radiation detection and measurements, John Wiley and Sons, New York, 1979.

Subject: Mechanics 1.
Code: TFBE0201
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0 (28 hours/semester)
Prerequisite: TFBE0101, TFBG0101, TMBE0603
Type of exam: oral/written examination
Responsible lecturer: Dr. Kornél Sailer

Lecturers: Dr. Kornél Sailer, Dr. Zsolt Schram

The aim of the course: The main objective of the course is to study the fundamental principles of mechanics, to derive the laws of mechanics. The principles and laws of mechanics are applied to a few simple examples which are important to develop the right view of the students on physical phenomena and which find applications throughout the whole Physics as simple models of more complicated phenomena. Through the principles and laws of Mechanics the course provides the students the fundamental knowledge to further studies in theoretical physics.
Topics: Kinematics of mechanical systems with a finite number of degrees of freedom. The least ction principle, Euler-Lagrange equations of motion. Galilei's relativity principle. Newton's laws. Symmetries and global conservation laws. Local conservation laws. Hamilton's canonical formalism, Hamilton equations, canonical transformations. Particular examples: small oscillations, Kepler's laws, pendula.

Compulsory/Recommended Readings:
1. H. Goldstein, C.P. Poole, J.L. Safko: Classical Mechanics
2. Landau, E.M. Lifsic: Theoretical Physics I. Mechanics
3. Budó Ágoston: Mechanika, Tankönyvkiadó
4. Bába Ágoston: Mechanika, Kossuth Egyetemi Kiadó
5. Sailer Kornél: Bevezetés a mechanikába, elektronikus jegyzet

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Subject: Mechanics practical 1.
Code: TFBG0201
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+2+0 (28 hours/semester)
Prerequisite: TFBE0101, TMBE0603
Type of exam: written examination
Responsible lecturer: Dr. Kornél Sailer
Lecturers: Dr. Kornél Sailer, Dr. Zsolt Schram

The aim of the course: The main objective of the practical course is to develop analytic evaluation methods and applications of the laws of Mechanics.
Topics: Problem solving related to the topics of Mechanics 1.

Compulsory/Recommended Readings:
1. H. Goldstein, C.P. Poole, J.L. Safko: Classical Mechanics (problems in the textbook)
2. Bába Á.,Bárdos Gy., Molnár L., Szaniszló J: Bázisfeladatok az elméleti mechanika gyakorlatokhoz. Kossuth Egyetemi Kiadó

Subject: Mechanics 2.
Code: TFBE0202
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0 (28 hours/semester)

Prerequisite: TFBE0201, TFBG0201,TMBE0604
Type of exam: oral/written examination
Responsible lecturer: Dr. Kornél Sailer
Lecturers: Dr. Kornél Sailer, Dr. Zsolt Schram

The aim of the course: The main objective of the course is to apply the laws of Mechanics to rigid bodies and continuous media (deformation of elastic materials, flow of gases and fluids). A great many technical solutions are based on the laws studied in the course. The knowledge of mechanics of continuous media is fundamental for further studies in classical field theory (electrodynamics) as well as in quantum field theory (nuclear physics, particle physics).
Topics: Angular velocity, moment of inertia, angular momentum of rigid bodies. Equations of motion of rigid bodies. Equilibrium of rigid bodies. Rotation about an axis, physical and torsion pendula. Rotation about a point, gyroscope. Small-amplitude oscillations, normal modes. Deformable media, deformation tensor and stress tensor, Hook's law. Local conservation laws. Elastic oscillations on strings and membranes. Elastic waves. Flaw of fluids and gases. Continuity equation. Ideal fluids (Euler and Bernoulli equations). Laminar flaw. Vortices. Water waves. Sound waves. Flaw of viscous fluids (Navier-Stokes equations). Solitons.

Compulsory/Recommended Readings:

1. H. Goldstein, C.P. Poole, J.L. Safko: Classical Mechanics
2. L.D. Landau, E.M. Lifsic: Theoretical Physics I. Mechanics, VI. Fluid Mechanics, VII. Theory of Elasticity
3. Budó Ágoston: Mechanika, Tankönyvkiadó
4. Bába Ágoston: Mechanika, Kossuth Egyetemi Kiadó
5. Lev D. Landau, Jevgenyij M. Lifsic: Elméleti fizika I (Mechanika), VII (Rugalmasságtan)

Subject: Mechanics practical 2.
Code: TFBG0202
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+2+0 (28 hours/semester)
Prerequisite: TFBE0201, TFBG0201 TMBE0604
Type of exam: written examination
Responsible lecturer: Dr. Kornél Sailer
Lecturers: Dr. Kornél Sailer, Dr. Zsolt Schram

The aim of the course: The main objective of the practical course is to develop analytic evaluation methods and applications of the laws of Mechanics for rigid bodies, elastic media, and flows of fluids and gases.
Topics: Problem solving related to the topics of Mechanics 2.

Compulsory/Recommended Readings:

1. H. Goldstein, C.P. Poole, J.L. Safko: Classical Mechanics (problems in the textbook)
2. Bába Á.,Bárdos Gy., Molnár L., Szaniszló J: Bázisfeladatok az elméleti mechanika gyakorlatokhoz. Kossuth Egyetemi Kiadó

Subject: Electrodynamics
Code: TFBE0203
ECTS Credit Points: 2
Lecture+practical+lab.practical courses/week: 2+0+0 (28 hours/semester)
Prerequisite: TFBE0103, TMBE0605
Type of exam: Oral exam at the end of the semester
Responsible lecturer: Dr. Ágnes Vibók
Lecturer: Dr. Ágnes Vibók

The aim of the course: Introduction to the theoretical description of the classical electrodynamics.
Topics: The Maxwell equations in differential and integral forms. Boundary conditions at interfaces between different media. Electrostatics. Magnetostatics. Energy in electric and magnetic field. Time- varying field, conservation laws. Vector and scalar potentials. Gauge transformations, Lorentz gauge, Coulomb gauge. Plane electromagnetic waves and wave propagation.

Compulsory/Recommended Readings:

1. J. D. Jackson: Classical Electrodynamics, John Wiley & Sons, New York 1975.

Subject: Electrodynamics practical
Code: TFBG0203
ECTS Credit Points: 2
Lecture+practical+lab.practical courses/week: 0+2+0 (28 hours/semester)
Prerequisite: TFBE0103, TMBE0605
Type of exam: Written examination
Responsible lecturer: Dr. Ágnes Vibók
Lecturer: Dr. Ágnes Vibók

The aim of the course: The primary objective of the course is to teach the basic problem solution skills and to reinforce the lectures.
Topics: Overview of necessary elements for differential and integral calculations, vector algebra and vector analysis. Solution of problems in physics from topics of subject encoded TFBE0203.

Compulsory/Recommended Readings:

1. J. D. Jackson: Classical Electrodynamics, John Wiley & Sons, New York 1975.
2. Basis exercises: Electrodynamics

Subject: Theory of Relativity
Code: TFBE0204
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0 (28 hours/semester)
Prerequisite: TFBE0103, TMBE0605
Type of exam: Oral examination at the end of the semester
Responsible lecturer: Dr. Zsolt Schram

Lecturer: Dr. Zsolt Schram

The aim of the course: To introduce the basic concepts of special and general relativity, relativistic formulation of theoretical mechanics, electrodynamics, field theory. Preparation of students for advanced studies (particle physics, relativistic quantum fields, cosmology, etc.).
Topics: Physics and geometry. Principle of relativity in classical mechanics and electrodynamics. Propagation of light. Co-ordinate transformations, Minkowski space. Tensors. Manifestly covariant formulation of electrodynamics. Relativistic mechanics. Relativistic field theory. Symmetries and conservation laws. Gravitation, equivalence principle. General co-ordinates, basic notions of differential geometry (parallel transport, curvature, etc.). Electrodynamics in curvilinear co-ordinate systems. Mechanics, inertial forces and geometry. Einstein equations, simple solutions.

Compulsory/Recommended Readings:

1. Taylor, E.F. and Wheeler, J.A. : Space-time physics
2. Landau, L.D. and Lifsic, E.M. : Theoretical Physics II., Classical fields
3. Misner, Wheeler, Thorne : Gravitation

Subject: Quantum Mechanics 1.
Code: TFBE0205
ECTS Credit Points: 4
Lecture+practical+lab.practical courses/week: 3+0+0
Prerequisite: TFBE0104, TFBE0208
Type of exam: Oral examination at the end of the semester
Responsible lecturer: Dr. Ágnes Nagy
Lecturers: Dr. Ágnes Nagy, Dr Zsolt Gulácsi

The aim of the course: To introduce the basic concepts of quantum mechanics.
Topics: Overview of fundamental experiments. Observables, operators, eigenvalues. Schrödinger equation. Eigenvalue equations of simple models. Free particle, harmonic oscillator. Hydrogen atom. Angular momentum. Time-dependence of quantum states. Probability interpretation of the wave function. Heisenberg uncertainty relation. Tunneling effect. Spin. Identical particles, Pauli principle. Symmetries and conservation theorems.

Compulsory/Recommended Readings:

1. A. Z. Capri, Non-relativistic Quantum Mechanics, The Benjamin/.Cummings Publ. Co. Menlo Park, California, 1985.
2. F. Schwabl, Quantum Mechanics, Springer, Berlin, 1990.
3. P. Gombás and D. Kisdi, Wave mechanics and its applications, Publ. House of the Hungarian Academy of Sciences, Budapest, 1973.

Subject: Quantum mechanics practical 1.
Code: TFBG0205
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+2+0

Prerequisite: TFBE0104, TFBE0208
Type of exam: two written tests during the semester
Responsible lecturer: Dr. Ágnes Nagy
Lecturers: Dr. Ágnes Nagy, Dr Zsolt Gulácsi

The aim of the course: To understand the basic concepts of quantum mechanics and solve problems.
Topics: Solution of problems in quantum mechanics

Compulsory/Recommended Readings:

1. S. Flügge, Practical Quantum Mechanics, Springer, Berlin, 1971.
2. D. ter Haar, Selected Problems in Quantum Mechanics, Academic Press, New York, 1964.
3. P. Gombás and D. Kisdi, Wave mechanics and its applications, Publ. House of the Hungarian Academy of Sciences, Budapest, 1973.

Subject: Thermodynamics and statistical physics
Code: TFBE0206
ECTS Credit Points: 4
Lecture+practical+lab.practical courses/week: 3+0+0
Prerequisite: TFBE0104, TFBE0208
Type of exam: oral exam at the end of the semester
Responsible lecturer: Dr. Ágnes Nagy
Lecturers: Dr. Ágnes Nagy, Dr Kornél Sailer

The aim of the course: To introduce the basic concepts of thermodynamics and statistical physics, to present the relation of phenomenological and statistical description.
Topics: Extensive and intensive quantities. Thermodynamical potentials. The laws of thermodynamics. The macroscopic and microscopic states. Statistical ensembles. Pure and mixed states. Liouville theorem and equation. Entropy and information. Equipartion and virial theorem. Classical ideal and real gas. Ideal Bose and Fermi systems.

Compulsory/Recommended Readings:

1. R. K. Pathria, Statistical Mechanics, Pergamon, Oxford, 1972.
2. R. Balian, From Microphysics to Macrophysics, Springer, Berlin, 1991.
3. K. Stowe, Introduction to Statistical Mechanics and Thermodynamics, Wiley, New York, 1984.

Subject: Introduction to electrodynamics
Code: TFBE0208
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: TFBE0103, TFBE0201, TMBE0605,
Substitution course: Electrodynamics, TFBE0203
Type of exam: oral exam at the end of the semester
Responsible lecturer: Dr. Ágnes Vibók
Lecturer: Dr. Ágnes Vibók

The aim of the course: Introduction to the theoretical description of the classical electrodynamics.
Topics: The Maxwell equations in differential and integral forms. Boundary conditions at interfaces between different media. Electrostatics. Magnetostatics. Energy in electric and magnetic field. Time- varying field, conservation laws. Vector and scalar potentials. Gauge transformations, Lorentz gauge, Coulomb gauge. Plane electromagnetic waves and wave propagation.

Compulsory/Recommended Readings:

1. J. D. Jackson: Classical Electrodynamics, John Wiley & Sons, New York 1975.

Subject: Introduction to quantum mechanics
Code: TFBE0209
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: TFBE0104, TFBE0208
Substitution course: Quantum mechanics 1., TFBE0205
Type of exam: oral exam at the end of the semester
Responsible lecturer: Dr. Ágnes Nagy
Lecturer: Dr. Ágnes Nagy, Dr Zsolt Gulácsi

The aim of the course: To introduce the basic concepts of quantum mechanics.
Topics: Overview of fundamental experiments. Observables, operators, eigenvalues.
Schrödinger equation. Eigenvalue equations of simple models. Free particle, harmonic oscillator. Hydrogen atom. Angular momentum. Time-dependence of quantum states. Probability interpretation of the wave function. Heisenberg uncertainty relation. Spin. Identical particles, Pauli principle.

Compulsory/Recommended Readings:

1. A. Z. Capri, Non-relativistic Quantum Mechanics, The Benjamin/.Cummings Publ. Co. Menlo Park, California, 1985.
2. F. Schwabl, Quantum Mechanics, Springer, Berlin, 1990.
3. P. Gombás and D. Kisdi, Wave mechanics and its applications, Publ. House of the Hungarian Academy of Sciences, Budapest, 1973.

Subject: Mathematics 3.: Linear algebra and group theory
Code: TMBE0605
ECTS Credit Points: 5
Lecture+practical+lab.practical courses/week: 3+2+0
Prerequisite: TMBE0603
Lecturer: Péter T. Nagy, DSc.

Topics: Algebraic structures, factor structures, homomorphisms, isomorphisms. Basic notions of group theory: normal subgroups, direct and semi-direct products. Permutation groups. Rings and fields. Vector space, basis, dimension. Subspaces, factor spaces, direct sums, tensor products. Linear operators and transformations, matrix forms. Eigenvectors, eigenvalues, characteristic polynomial. Euclidean and unitary vector spaces. Orthogonal direct sum. Orthonormal basis. Adjoint operator, selfadjoint operators. Classical linear groups. Linear representations.

Compulsory/Recommended Readings:

1. Lang, S.: Introduction to linear algebra, Springer, 1986.
2. Spindler, K.: Abstract algebra with applications**,** M. Dekker, New York, 1994.

Subject: Applied of probability calculus
Code: TFBE0606
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: TMBE0604
Type of exam: oral exam at the end of the semester
Responsible lecturer: Dr. Gyula Pap
Lecturer: Dr. Gyula Pap

The aim of the course: Introduction to the theory of stochastic processes.
Topics: Discrete time Markov chains. Examples: stochastic motion with, absorbing and reflecting walls, the Ehrenfest and Bernuolli-Laplace model of diffusion, branching processes, Markov chains with recurrent events, transition probabilities, Chapman-Kolmogorov equation, closed set of states, classification of states (important and unimportant states, periodicity, subclasses). Reoccurrence, transient states, ergodicity, invariant distribution. Finite base state Markov chains. Absorbtion probabilities, the problem of getting spoiled. Inverse chains, reversibility.
Continuous time Markov chains. Transition probabilities, Chapman-Kolmogorov equation, Kolmogorov differential equations. Finite base state Markov chains. The mechanism of state transitions. Instantaneous regular and drain states. Discrete time frame. Classification of states. Reoccurrence, transient states, ergodicity, invariant distribution. Examples: creation-annihilation processes, Karlin-McGregor theorem, pure creation processes. Poisson process, Yule process, Pólya process.

Compulsory/Recommended Readings:

1. W. Feller: Bevezetés a valószínûségszámításba és alkalmazásaiba. Mûszaki Könyvkiadó, 1978.
2. S. Karlin, H.M. Taylor: Sztochasztikus folyamatok. Gondolat, Budapest, 1985.
3. A.T. Bharucha-Reid: Elements of the theory of Markov processes and their applications. New York [et al.] : McGraw-Hill Book Company, 1960.
4. A.T. Bharucha-Reid: Probabilistic methods in applied mathematics. New York : Academic Press, 1968.
5. Pap Gyula: Sztochasztikus folyamatok. Egyetemi jegyzet, mobiDIÁK könyvtár, 2004, http://mobidiak.inf.unideb.hu/mobi/main.mobi

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Subject: Computer Controlled Measurement and Process Control
Code: TFBE0602

ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: TFBE0302
Type of exam: oral exam at the end of the semester
Responsible lecturer: Dr. Habil Sándor Sudár
Lecturer: Dr. Habil Sándor Sudár, Dr. Gyula Zilizi , Dr. László Oláh, Zoltán Szillási

The aim of the course: The course provides the basic idea of the computer controlled measurement and control.
Topics: Structure of measuring systems, basic elements of the measuring system. Evolution of the computer controlled measurements. Unified connection systems (CAMAC, IEC, etc.). Data transfer modes between the computers and measuring equipment, communication procedures. Computer operation systems and their effect on measurements. Realization of the computer controlled measurements in different programming languages, programming tools. Basics of the process control, type of the control systems. Processes control by computer. Examples for real measuring and process controller systems. Fuzzy logic, neural networks and theirs application in the process control.

Compulsory/Recommended Readings:

1. Doebelin O.E.: Measurement Systems. Application and Design. McGraw-Hill, NewYork, 2004.
2. Kahler J., Frank H. Fuzzy-Logik und Fuzzy-Control, VIEWEG, 1994
3. M. Nørgaard, O. Ravn, N. K. Poulsen and L. K. Hansen: Neural Networks for Modelling and Control of Dynamic Systems, Springer-Verlag, London, 2000

Subject: Analog electronics
Code: TFBE0303
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: TFBE0301
Type of exam: Written or oral exam
Responsible lecturer: Dr. Gyula Zilizi
Lecturer: Dr. Gyula Zilizi, Dr. László Oláh

Topics: Bipolar transistors, field-effect transistors, and MOS transistors for analog electronics applications. Analysis of multi-stage amplifiers. Audio amplifiers (preamps, equalizers, power amplifiers). Transfer characteristics, distortion, power efficiency, impedance. Frequency response, stability and frequency-compensation of multi-stage feedback amplifiers. Electronic noise in circuits, including thermal noise, shot noise, and 1/f noise. Review of general-purpose op-amps, audio and wideband video op-amps. Selected topics in analog video technology. Linear and nonlinear analog applications: power supplies, precision rectifiers, differentiators, integrators, phase-locked loops. Analog electronic circuits for use in control systems, instrumentation and telecommunications.

Compulsory/Recommended Readings:

1. Paul Horowitz, Winfield Hill: The Art of Electronics (Cambridge University Press, Cambridge, USA, 1993)

Subject: Computer Architecture
Code: TFBE0304
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: TFBE0302
Type of exam: Written or oral exam
Responsible lecturer: Dr. Gyula Zilizi
Lecturer: Dr. Gyula Zilizi, Dr. László Oláh

Topics: Typical parts and organization of digital microcomputers. A detailed look at the CPU. Architecture of Intel and compatible CPUs. Evolution of the IBM PC and compatible computers (XT, AT, 386, 486, Pentium 1-4 PCs. Motherboards, chipsets. Bus architecture, IBM PC bus signals. Expansion slots, overview of standard interfaces (ISA, VLB, PCI, AGP, PCI-Express). BIOS. Interrupts and direct memory access (DMA). The evolution of graphics cards from MDA to 3D accelerated VGA cards. Serial and parallel ports, USB.

Compulsory/Recommended Readings:

1. Paul Horowitz, Winfield Hill: The Art of Electronics (Cambridge University Press, USA, 1993);
   http://www.tomshardware.com

Subject: Computer simulation methods
Code: TFB0604
ECTS Credit Points: 5
Lecture+practical+lab.practical courses/week: 1+0+4
Prerequisite: TFBE0601, TMBE0604
Type of exam: two written tests during the semester
Responsible lecturer: Dr. Ferenc Kun
Lecturer: Dr. Ferenc Kun

The aim of the course: To introduce the basic methods of computer simulations.
Topics: Relation of experiment, theory, and simulation, the exact numerical solution of models, classification of simulation methods.
Monte Carlo simulation: random number generators, random numbers with uniform and arbitrary distributions. Computer simulation of random walks, growth processes, diffusion, and diffusion limited aggregation, Eden model, damage spreading.
Percolation processes, percolation on a lattice, directed percolation, invasion percolation, penetration of fluids in porous media, phase transitions and critical phenomena.
Monte Carlo integration: simple sampling and importance sampling, high dimensional integrals, Metropolis algorithm, Monte Carlo simulation of the Ising model. Application: Monte Carlo simulation of the fracture of fibre reinforced composites, thermally activated cracking.
Molecular dynamics simulation: numerical solution of ordinary differential equation systems. Equation of motion, initial and boundary conditions. Optimization of simulation programs, force table, Verlet table, linked-cell algorithms.
Applications: computer simulation of fracture processes of concrete under uniaxial tensile and compressive loading, effect of reinforcement by short and long steal fibres.

Cellular automata simulations: classification of cellular automata, coding of the dynamics. Lattice gas models. Applications: computer simulation of fluid flow, flow-field around an obstacle, particles in fluids, colloids.

Compulsory/Recommended Readings:

1. V. Gould and J. Tobochnik, *An introduction to Computer Simulation Methods* (Addison-Wesley, 1999).
2. M. P. Allen and D. J. Tildesley, *Computer Simulation of Liquids* (Oxford University Press, 1996).
3. D. Rapaport, *The Art of Molecular Dynamics Simulation*, (Cambridge University Press, 2001).
4. K. Ohno, K. Esfarjani, and Z. Kawazoe, Computational Materials Science, (Springer, 1999).

Subject: Statistical Data Analysis
Code: TFBE0603
ECTS Credit Points: 4
Lecture+practical+lab.practical courses/week: 2+1+0
Prerequisite: TFB0101, TMBE0603
Type of exam: written and oral exam at the end of the semester, and two written tests during the semester
Responsible lecturer: Dr. Zoltán Trócsányi
Lecturer: Dr. Judit Darai, Dr. Zoltán Trócsányi

The aim of the course: To get the students acquainted with mathematical methods of statistical data analysis, and demonstration of their use via examples.
Topics: Elements of probability theory: probability variables and their properties, probability distributions. Statistical estimates and their properties. Propagation of errors. The Monte-Carlo method. Statistical tests: hypotheses, linear discrimination function of Fischer, fitting tests, signal significance. Maximum likelihood method: estimation of parameters, uncertainty of maximum-likelihood estimates (analytic, graphical and Monte Carlo methods, RCF-limit). Estimation of parameters using least squares method, uncertainty of estimates. Fitting linear functions of parameters.
Numerical methods. Sources of uncertainties, finite precision numbers. Solving non-linear equations: fixed point iterations, Newton-Raphson method, Brent's method. Coupled system of equations of two unknowns: fixed-point iterations, Newton-Raphson method, gradient method. Algebraic equations: Horner’s method, Vieta-theorem, Lobacsevszkij-Graeffe method. Solving coupled system of linear equations: Gauss’ elimination, iterations; poorly defined systems, geometrical demonstration. Numerical integration: general quadrature, trapezoidal method, Simpson’s method. Numerical integration of differential equations: basic problem and its generalizations, Euler’s method, Taylor’s method.

Compulsory/Recommended Readings:

1. Glen Cowan: Statistical Data Analysis, Oxford Science Publications, 1998
2. A. Ralston: Bevezetés a numerikus analízisbe Műszaki Könyvkiadó, Bp., 1969

Subject: Laboratory Practical in Computer Controlled Measurement and Process Control
Code: TFBL0602
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 0+0+4
Prerequisite: TFBE0602
Type of exam: practical mark
Responsible lecturer: Dr. Habil Sándor Sudár
Lecturer: Dr. Habil Sándor Sudár, Dr. Gyula Zilizi , Dr. László Oláh, Zoltán Szillási

The aim of the course: Application of the basic idea and programming methods of the computer controlled measurement and control.
Topics: Introduction to LabVIEW, LabVIEW Virtual Instruments, Creating, Editing, and Debugging a VI, Creating a SubVI, Loops and Charts, Arrays, Graphs and Clusters, (Creating arrays, Waveform and XY Graphs), Case and Sequence Structures, Formula and Expression Nodes, Strings and File I/O (Build String VI, File I/O VIs and Functions, Formatting Spreadsheet Strings); Data Acquisition and Waveforms (Data Acquisition (DAQ) Overview, Organization of Data Acquisition VIs, Performing a Single Analog Input), DAQ Wizards, Waveform Analog Input, Writing Waveform Data to File, Scanning Multiple Analog Input Channels, Analog Output, Digital Input and Output, Counters;
Instrument Control Overview, GPIB Communication and Configuration.
Exercise for the I/O port handling. Making a computer controlled function generator by the D/A converters, amplitude and frequency control; Play back of digitally stored sound using D/A converter.

Compulsory/Recommended Readings:

1. LabVIEW User Manual, National Instruments, 2003
2. LabView Measurement Manual, National Instruments, 2003

Subject: Digital signal processing measurements
Code: TFBL0605
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+2 (24 hours/semester)
Prerequisite: TFBE0602
Type of exam: practical mark
Responsible lecturer: Dr. István Szabó
Lecturer: Dr. István Szabó, Dr. Lajos Harasztosi

Aim of the course: The students ate introduced to the concepts of digital signal processing and the applications of the digital signal processors.
Topics: Trough the practice the architecture of the DSP processor, the typical programming environment and the application of embedded measuring systems are introduced. Besides the traditional textual programming the use of graphical dataflow methods is also introduced. The topics of the laboratory practices are the following:
1. *Using the digital input and output periferial devices: Digital I/O, PWM signal generation.* Configuring the digital periferials for input and autput. Interfacing external devices (leeds and switches). A running light program. Programing logical conditions with switches. PWM signal generation using software timings. Digital signal measurement techniques.

2. *Using the analog input and output devices: A/D conversion, implementing a data collection program.*
Configuring the A/D converter. Design and application of an analog filter. Programming a Data logger. Study of the A/D conversion with a signal generator. Interfacing a sensor to the converter. Data collection with a mobile device. The presentation of the collected signals.
3 *ITiming and counting circuits: measuring rotation and angular velocity*
Configuring the counter/timer circuit. Examining the counting modes. Digital encoders. Implemeting a rotatin and angular velocity measurement. Measuring the rotation of an electric motor. Genertating PWS signals with the counter. Control of the rotational speed of an electric motor.with PWM signals
4. *Basics of Digital filteringi,Implemeting and examining a FIR filter.*
Digital filter types: FIR and IIR. Filter design. Implementation of a real time digital filter with a DSP processor. Characterisation of the filter response in the time and frequency domains
5. *Basics of control design. Study of a PID controller.*
Study of basic control techniques using computer simulation. Implementing and analysing a temperature controlling PID regulator with a DSP processor.
6. *Motor control: study of various electric motors and controlles and their characteristics.*
Control of a stepper motor. Measuring the characteristis of a DC motor: speed and torque. Cotrolling a DC motor under changing load.

Compulsory/Recommended Readings:

1. Manual for each laboratory practice
2. Andreev Bateman, Iain Paterson-Stephens: THE DSP HANDBOOK Prentice Hall 2002
3. Texas Instruments felhasználói kézikönyvek
4. Steven W. Smith,: The Scientists and engineers guide to Digital Signal processing http://www.dspguide.com/

Subject: Practice in solid state physics 2.
Code: TFBL0514
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1
Prerequisite: None
Type of exam: written tests during the semester
Responsible lecturer: Dr. Gábor Langer
Lecturer: : Dr. Csaba Cserháti, Dr. Lajos Daróczi, Dr. Gábor Erdélyi, Dr. Sándor Szabó, Dr. Lajos Harasztosi

The aim of the course: The practice gives an insight into the present day solid state physics research.
Description of the topics of the course: Thermal behaviour of ferromagnetic materials. Metallography. Measurements using scanning electron microscope. Measurements by transmission electron microscope. Producing of alloys by arc-melting. Deposition and investigation of multilayers

Compulsory/Recommended Readings:

1. D. Halliday, R. Resnick and J. Krane: Fundamentals of Physics, John Wiley & Sons Inc.

2. Milton Ohring, The Materials Science of Thin Films, Academic Press, Inc. Boston
3. Lecture notes, written by the lecturers.

Subject: Laboratory Practicals in Optics and Atomic Physics 2.
Code: TFBL0512
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1 (4x4 hours/semester)
Prerequisite: TFBE0104
Type of exam: practical mark
Responsible lecturer: Dr. Endre Takács
Lecturer: Dr. Péter Raics, Dr. Endre Takács

The aim of the course: Practice of experimenting, experimental verification of the main laws of atomic physics, the application of statistical data analysis at an advanced level
Topics: Measurements with a Török-Barabás type spectroscpe, Measurement of the index of refraction and material composition using a Rayleigh-interferometer, Operation and parameters of a He-Ne gas laser.

Compulsory/Recommended Readings:

1. Szabó J., Raics P. : Atomfizikai és optikai laboratóriumi gyakorlatok KLTE, 1986 (házi jegyzet)

Subject: Laboratory practical in nuclear physics 2.
Code TFBL0515
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1 (4x4 hours/semester)
Prerequisite: TFBE0104
Type of exam: practical mark
Responsible senior lecturer: Dr. Habil Sándor Sudár
Lecturers: Dr. Habil Sándor Sudár, Dr. Ferenc Cserpák, Dr. Magdolna Váradi

The aim of the course: Practicing in the different nuclear measurement data evaluation.
Topics: Half-life of radioactive isotopes. Examination of cosmic rays. Determination of nuclear radius by total neutron cross-section measurements. Neutron absorption measurements. γ-γ angular correlation measurements. Measurements with solid state nuclear track detectors.

Compulsory/Recommended Readings:

1. Nuclear Physics Laboratory Manual

Subject: Laboratory practicals in electronics 3.
Code TFBL0509
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1 (4x4 hours/semester)

Prerequisite: TFBL0507, TFBL0509
Type of exam: practical mark
Responsible senior lecturer: Dr. László Oláh
Lecturers: Dr. László Oláh, Dr. Gyula Zilizi

The aim of the course: The objective of the course is to teach advanced experimental skills in electronic measurements by digital oscilloscopes and to study A/D converter and PLL circuits
Topics: Measurements with digital oscilloscopes. A/D converters. Introduction to the utilisation of LABVIEW. PLL circuits.

Compulsory/Recommended Readings:

1. Sztaricskai T.: Mérések digitális oscilloszkóppal (KLTE, TTK, Kísérleti Fizikai Tanszék, tanszéki jegyzet, 1973).
2. Oláh László: Elektronikus laboratóriumi mérések III. (DEE, TTK, Kísérleti Fizikai Tanszék, tanszéki jegyzet, 2005).

Subject: Circuit simulation 1.
Code TFBL0305
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+1+0
Prerequisite: TFBE0303
Type of exam: practical mark
Responsible senior lecturer: Dr. Gyula Zilizi
Lecturers: Zsolt Szabó, Dr. Gyula Zilizi, Dr. László Oláh

Topics: Computational methods in circuit design. Linear and nonlinear simulation programs (TINA, SPICE etc). DC, transient, frequency and noise analysis. Excitation of linear networks by sine-wave and pulses. Characteristics of different electronics parts and devices.

Compulsory/Recommended Readings:

1. TINA 3.0 Users Guide (DesignSoft Budapest)

Subject: Circuit simulation 2.
Code TFBL0306
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+1+0 (4x4 hours/semester)
Prerequisite: TFBE0303
Type of exam: practical mark
Responsible senior lecturer: Dr. Gyula Zilizi
Lecturers: Zsolt Szabó, Dr. Gyula Zilizi, Dr. László Oláh

Topics: Advanced PSPICE and TINA simulation exercises. Determination of model parameters. Source types and parameters. Simulation options and control statements. Modelling linear electronics parts. Semiconductors, diodes, MOS and bipolar transistors. The linear model of op-amps. AC analysis, Bode-diagram. Simulation of digital electronics circuits.

Compulsory/Recommended Readings:

1. Paul W. Tuinenga: SPICE: A Guide to Circuit Simulation and Analysis Using PSpice (Prentice Hall 1995); http://www.electronicsworkbench.com/spice/

Subject: Application of Microcontrollers 1.
Code TFBE0307
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1
Prerequisite: TFBE0302
Type of exam: practical mark
Responsible senior lecturer: Dr. Gyula Zilizi
Lecturers: Zsolt Szabó, Dr. Gyula Zilizi, Dr. László Oláh

Aim of the course: Introduction to application of low-level programming languages in control techologies.
Topics: History of single-chip computers. The general architecture of the 8-bit microcomputers. Architecture of the Basic Stamp. Intelligent displays.

Compulsory/Recommended Readings:

1. Dr. Madarász László: A PIC16C Mikrovezérlők, GAMF, Kecskemét, 1996
2. P. F. Lister: Single-chip microcomputers William Collins Sons & Co. Ltd., Great Britain, 1988

Subject: Application of Microcontrollers 2.
Code TFBE0308
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1
Prerequisite: TFBE0302, TFBL0306
Type of exam: practical mark
Responsible senior lecturer: Dr. Gyula Zilizi
Lecturers: Zsolt Szabó, Dr. Gyula Zilizi, Dr. László Oláh

Topics: The MCS48 and the MCS51 family. Microcontrollers with RISC technology. Instruction set of the MICROCHIP's microcomputers. The hardware and software characteristic of the PIC16F84. Integrated Development Environment (IDE) on PC. Some 8-, 16-, and 32 bit microcontrollers from different manufacturers (ATMEL, Cygnal, Cypress, Texas, Philips, Hitachi, Dallas). Microcontrollers in networking applications.

Compulsory/Recommended Readings:

1. Dr. Madarász László: A PIC16C Mikrovezérlők, GAMF, Kecskemét, 1996
2. P. F. Lister:Single-chip microcomputers William Collins Sons & Co. Ltd., Great Britain, 1988
3. Handbooks and manuals of the microcontrollers (See manufacturers' web pages)

Subject: Atomic and Molecular Physics

Code TFBE0403
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: TFBE0104
Type of exam: oral exam at the end of the semester
Responsible senior lecturer: Dr. Imre Szalóki
Lecturers: Dr. Imre Szalóki, Dr. Endre Takács

The aim of the course: This subject provides a systematic overview of the fundamental effects and experimental methods of atomic and quantum physics and introduces to the molecular physics.
Topics: History of atomic theory and discovering of atomic structure.Electric charge, Rutherford scattering experiment, Planck theory for black-body radiation, photoelectric effect, Compton scattering, Frank-Hertz experiment, bremsstrahlung and characteristic X-ray radiation. Basic phenomena of the light. Bohr-Sommerfeld model of atoms, electron diffraction, de Broglie hypothesis, wave-particle duality. Basic elements of quantum mechanics: operators, Schrödinger equation, Heisenberg uncertainty principle. Quantum theory of rotator, harmonic oscillator, hydrogen atom and tunnelling effect. Spin, angular momentum, quantum numbers, atomic emission spectra, Zeeman and Stark effects, periodic table of elements, Pauli principle. Origin of X-ray and optical emission spectra, Auger effect, electron spectroscopy. Principle of laser and maser: stimulated emission of atoms, population inversion, application of lasers. Theory of molecules and valence bounds: covalent, ionic and metallic bonds, hydrogen bond, Raman scattering. Methods and facilities of atomic spectroscopy: accelerators, synchrotrons, X-ray tubes, energy and wavelengths dispersive detectors. Experimental methods of atomic physics and their applications: electron spin resonance, nuclear magnetic resonance, computer tomography, X-ray diffraction, X-ray absorption methods.

Compulsory/Recommended Readings:

Haken H., Wolf H. C., *Atomic and Quantum Physics*, Springer Verlag, 1984.

R. Eisberg and R. Resnick, *Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles*. John Wiley & Sons Inc., 1985.

Subject: Nuclear and Particle Physics
Code TFBE0404
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0 (24 hours/semester)
Prerequisite: TFBE0104
Type of exam: oral examination
Responsible senior lecturer: Dr. Péter Raics
Lecturer: Dr. Péter Raics

Aim of the course: The main objective of this introductory course is to study the fundamentals of the radioactivity, nuclear- and particle physics phenomena. Description by models. Application fields.
Topics: General properties and structure of nuclei, basic processes. Characteristic physical quantitites. Symmetries and conservation laws. Interaction of radiations with matter: charged particles, photons and neutrons. Detection and spectrometry of particles in gas-filled, scintillation and semiconductors materials. Tracking methods. Dosimetry. Basic laws of

radioacivity. Dimensions, mass, binding energy of the nuclei. Nuclear momenta. Models: charged liquid drop, statistical, shell, collective, unified. Fundamentals of neutron physics. Alpha-disintegration, beta-decay and parity violation, gamma-deexcitation. Nuclear energetics. Fission. Basic ideas of reactor physics. Thermonuclear fusion. Accelerators. Particles, production and categories. Fundamentals of the Standard Model of elementary particles and interactions. Quarks and leptons. Structure of the mesons and barions. Evolution of the matter and Universe.

Compulsory/Recommended Readings:

1. Raics P.: Atommag- és részecskefizika. Jegyzet. (DE Kísérleti Fizikai Tanszék, 2002.) http://fizika.ttk.unideb.hu/kisfiz/Raics
2. Csikainé Buczkó M.: Radioaktivitás és atommagfizika (Tankönyvkiadó, Bp., 1985)
3. Raics P., Sükösd Cs.: Atommag- és részecskefizika. Könyvrészlet "A fizika alapjai" c. tankönyvben, VI. rész, 635-714 o. (Szerk: Erostyák J., Litz J. Nemzeti Tankönyvkiadó, Budapest, 2003)
4. Sükösd Cs.: Atommagfizika. VII. rész, „Fizika III." 329-482 (szerk. Erostyák J., Litz J., Nemzeti Tankönyvkiadó, Budapest, 2006.)
5. Raics P.: Részecskefizika. VIII. rész, „Fizika III." 485-540 (szerk. Erostyák J., Litz J., Nemzeti Tankönyvkiadó, Budapest, 2006.)
6. Fényes T. (szerk.): Atommagfizika. (Debreceni Egyetem, Kossuth Egyetemi Kiadó, 2005.)
7. R.Eisberg, R.Resnick: Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles (2nd ed. J.Wiley, New York, 1985.)
8. K.Heyde: Basic Ideas and Concepts in Nuclear Physics. (IOP Publishing Co, Bristol, 1994.)
9. R.Bigelow, M.Moloney, J.Philpott, J.Rothberg: Nuclear and Particle Physics Simulations. (CUPS, J.Wiley, New York, 1995.)
10. D.Halliday, R.Resnick, J.Walker: Fundamentals of Physics, Part 5. (J.Wiley, New York, 1997.)

Subject: Modern Optics
Code TFBE0406
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0 (24 hours/semester)
Prerequisite: TFBE0104
Type of exam: oral examination
Responsible senior lecturer: Dr. Péter Raics
Lecturer: Dr. Péter Raics, Dr. Sándor Kökényesi

Aim of the course: The main objective of the course is to study contemporary optics phenomena, their explanation and applications, optical devices, methods.
Topics: Superposition of light waves, coherence, interference and applications. Diffraction. Wave optical model of imaging. Fourier-transform and its utilisation in optics. Wavefront reconstruction. Applications of holography. Detection of light: photoeffect in metals, semiconductors and dielectrics; thermal methods, special techniques. Interactions of light, matter and electromagnetic fields. Linear electrooptic and magnetooptic phenomena. Non-linear optical effects. Adaptive optics. General characteristics of light sources; absorption, spontaneous and stimulated emission. Fundamentals of laser operation. Vapour- and gas

lasers. Solid state lasers from crystals, glasses, semiconductors. Special techniques: dye-, excimer- and free-electron lasers. Fundamentals of fiber optics: theory, technology of production, applications. Optical measurement techniques and utilisation in biology and medicine.

Compulsory/Recommended Readings:

Nussbaum, R.A.Phillips: Modern optika (Műszaki Könyvkiadó, Budapest 1982)
Contemporary Optics for Scientists and Engineers (Prentice Hall Inc. Englewood Cliffs, New Jersey, 1980)
Ábrahám Gy. (szerk.): Optika (Panem̃McGraw-Hill, Budapest, 1998)
Raics P.: A Fourier-transzformáció alapképletei (Jegyzet. KLTE, Debrecen, 1984)
Erostyák J.: Fénytan. Fizika III., IV.rész. 14–199. (szerk. Erostyák J., Litz J., Nemzeti Tankönyvkiadó, Budapest, 2006.)
R.Eisberg, R.Resnick: Quantum Physics of atoms, molecules, solids, nuclei and particles.(2nd ed, J.Wiley & Sons, New York, 1985)
W.Christian, A.Antonelli, S.Fischer, R.A.Giles, B.W.James, R.Stoner: Waves and Optics Simulations. (CUPS, J.Wiley, New York, 1995.)
W.Demtröder: Laser Spectroscopy. (2nd ed., Springer-Verlag, Berlin, 1996.)
D.G.Feitelson: Optical Computing. (MIT Press, Cambridge-Massachusetts, 1988.)
R.D.Guenther: Modern Optics (J.Wiley & Sons, New York, 1990)
M.J.Howes, D.V.Morgan (ed.): Optical fibre communications (John Wiley & Sons, New York, 1980)
P.W.Milonni: Lasers (J.Wiley &Sons, New York, 1988)

Subject: Electron and Atomic Microscopy
Code: TFBE0407
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: None
Type of exam: oral examination
Responsible senior lecturer: Dr. Csaba Cserháti
Lecturer: Dr. Csaba Cserháti, Dr. Lajos Daróczi

The aim of the course: A course in the theory, fundamental operating principles, and specimen preparation techniques of the transmission electron microscope (TEM), scanning electron microscopy (SEM) and Scanning Probe Microscopes (SPM) is offered every year in the Fall semester.
Topics: Introduction to the practical and theoretical principles of the different eletron microscopes, X-ray microanalysis and electron diffraction. Electron beam-specimen interaction, electron and X-ray detectors. Specimen preparation techniques for TEM and SEM. Introduction to the principles of SPM and AFM.

Compulsory/Recommended Readings:

1. Scanning Electron Microscopy and X-ray Microanalysis; J.I.Goldstein, D.E.Newbury et al. Plenum Press New York 1981
2. Principles of Analytical Electron Microscopy ed. By D.C.Joy, A.D.Romid, J.I.Goldstein Plenum Press New York 1989
3. Transmission Electron Microscopy and Diffractometry of Materials, B.Fultz, J.M.Howe Springer 2001

Subject: Neutron- and reactor physics
Code: TFBE0414

ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: TFBE0104
Type of exam: oral examination
Responsible senior lecturer: Dr. András Demény
Lecturer: Dr. András Demény

The aim of the course: During the coursework students will learn about the part of nuclear physics that deals with neutrons and about systems for energy production based on nuclear fission.
Topics: Basics of neutron physics. Neutron sources. Neutron detectors. Deceleration and diffusion of neutrons. Determination of the energy spectrum and and flux of neutrons. Measurement methods for cross sections. Optical properties and their applications. Nuclear fission. Critical systems. Heterogenous reactors. Homogenous reactors. Reactor kinetics and control

Compulsory/Recommended Readings:

1. K.H.Beckurts, K.Wirtz, Neutron Physics, Springer-Verlag (1964)
2. J.Csikai, Handbook of Fast Neutron Generators, CRC Press Inc., Florida (1987)
3. Kiss D., Quitner P., Neutronfizika, Akadémiai Kiadó, Budapest (1971)
4. Simonyi K. A reaktorfizika és reaktortechnika alapjai, Mérnöki Továbbképző Intézet, Budapest (1956)
5. S. Garg, F. Ahmed, L.S.Kothari, Physics of Nuclear Reactors, Tata McGraw-Hill Publishing Company Ltd., New Delhi (1986)
6. Szalay-Csikai, Radioaktivitás, KLTE-TTK (1970).

Subject: Laboratory practise on biophysical and biomedical problems
Code: TFBL0517
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+1
Prerequisite: TFBE0603, TFBE0602
Type of exam: Students are marked on the basis of their laboratory work and proceedings.
Responsible senior lecturer: Dr. Sándor Szabó
Lecturer: Dr. Sándor Szabó, Dr István Szabó

The aim of the course: There are several medical equipment and methods based on physical, and biophysical principles. Physicists can come into contact with this kind of equipment during work. That is why this laboratory practise introduce them into this field. During the occasions students works themshelves by equipment using the special biophysical methods. The goal is, that let they be able to solve similar problems in they later work.
Topics: Investigation of quasiperiodic effects by means of statistical methods:Measurement of dinamics of heart beat, walking, and respiration. Evaluation of measured parameters using statistical methods and quantities. Average values and deviations, correlation analysis. Numeric calculations by computer technique. Usage of DSP methods. Spectral analysis of biophysical effects: Detection of sounds. FFT and LPC analysis, Hamming, Hanning, Bartlett, methods etc. Difference between special noises and sound effects. Evaluations on the basis of computerized possibilities. Investigation of hearing:bGeneration a harmonic sounds.

Detection and graph of the range of audibility. Masc effects. Usage of sund generator, oscilloscope, and data evaluation by computer technique. Mechanical and structural propertires of bone and bone cement: Trace the polimerization of bone cement. Preparation of polished bone and cement samples. Microscopic and mechanical investigations. Hardness and pulling-pressing measurements. Analysis of the sign shapes: EKG, EEG investigation. Detections of data. Peak search and sign distribution analysis by digital technique.

Compulsory/Recommended Readings:

1. Moore, BCJ, Introduction to the Psychology of Hearing, Macmillan, NY (1977)
2. Roederer, JG, Introduction to the Physics and Psychophysics of Music, 2nd Edn. Heidelberg Science Library 1979
3. Ulf Lindén, Fatigue properties of bone cement, (Comparison of mixing techniques), Acta Orthop Scand, 1989, 60(4), 431-433
4. Mathematical Statistics with Applications by W. Mendenhall, D. D. Wackerly and R. L. Scheaffer (ISBN 0-534-92221-X) 2007-03-30

Subject: Technical Physics
Code: TFBL0516
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 1+0+3
Prerequisite: TFBE0102
Responsible senior lecturer: Dr. Sándor Kökényesi
Lecturer: Dr. Sándor Kökényesi

The aim of the course: To study the main types of materials and experimental technology which are used in applied physical investigations and create the basis of experimental skills.
Topics: Systematization of materials and their main characteristics. Technical plotting. Mechanical tooling: instruments and methods (hand instruments, drills, cutting instruments, lathe). Glass works: types of glass, handling, simple glass technology work. Vacuum technology: gases, pressure measurements, vacuum pumps, leakage detection, elements of vacuum equipment. Thin film technology. Cryostats, cooling equipment. Owens, annealing. Laboratory of electronics: simple circuit elements and assembly.

Compulsory/Recommended Readings:

1. L. Van Vlack, Elements of Materials Science and Engineering, Addison-Wesley Publishing Company, 1980.
2. Bánhalmi J. Vákuumfizika. Tankönyvkiadó, Budapest, 1983.
3. Proc. Workshop on Vacuum Technology, Yogyakarta, 1999.
4. Edmunds Scientific and similar catalogues.

Subject: Materials and Technology
Code: TFBE0408
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: None
Type of exam: written and oral exam at the end of the semester
Responsible senior lecturer: Dr. Gábor Langer

Lecturer: Dr. Gábor Langer

The aim of the course: The lecture gives an insight into the new materials and technologies.
Topics: Alloys. Mechanical property of layered system.. Magnetic materials, magnetic thin films. Magnetic multilayers. Materials for information storage. Photonic materials. Optical fiber. Semiconductor lasers. Optical data storage. Magnetic recording. Holographic memories. Shape memory alloys. Materials for clean energy. Fuel cell. Solar energy, solar cell. Diamond and hard materials. Ceramics. Biomaterials. Composite materials. Nanowires.

<u>Compulsory/Recommended Readings:</u>

1. Philip Ball, New Materials for the 21st century, Princeton University Press, 1997

Subject: Materials and technology for microelectronics
Code: TFBE0411
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0 (24 hours/semester)
Prerequisite: TFBE0405, TFBE0104
Type of exam: written and oral exam at the end of the semester
Responsible senior lecturer: Dr. Sandor Kökényesi
Lecturer: Dr. Sandor Kökényesi

Aim of the course: Introduction to the technology of materials, electronic elements and devices of microelectronics on the basis of materials science for further grounding of the applied science knowledge, its application to the industrial tasks.
Topic: Metals, semiconductors, dielectrics. Crystalline and amorphous materials. Characteristic properties, systematization. Band structure, electron transitions, electrical conductivity, optical effects. Contacts, p-n junction. Main types of semiconductors, their technology: Si, Ge, GaAs, CdS – type materials, their parameters. Thin films, main elements of the technology: vacuum evaporation, sputtering, CVD, MBE. Diffusion, implantation, lithography. SiO_2 insulating layers, technology of passive elements. Bipolar transistor, heterostructures, MOS FET and quantum- devices. Packaging, surface mounting. Optoelectronic elements, optical and other memory devices. Elements of functional electronics. Reliability, quality. The main directions of the industrial development .

<u>Compulsory/Recommended Readings:</u>

1. S.M. Sze, Semiconductor Devices (physics and technology), John Wiley and Sons, 2002,
2. S. Kasap, principles of Electronic Materials and Devices, McGraw-Hill, 2006.
3. Mikroelektronika és elektronikai technológia, szerk. Mojzes Imre, Műszaki Könyvkiadó, BME, 1995.
4. Mojzes Imre, Kökényesi Sándor, Fotonikai anyagok és eszközök, Műegyetemi Kiadó, 1997
5. Bársony István, Kökényesi Sándor, Funkcionális anyagok és technológiájuk, Főiskolai jegyzet, Debrecen, 2003.
6. Mojzes Imre, Pődör Bálint , Új anyagok és szerkezetek a mikrohullámú félvezető eszközökben, Akadémiai Kiadó, Budapest, 1993.

Subject: Vacuum Science and Technology
Code: TFBE0409
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: None
Type of exam: written and oral exam at the end of the semester
Responsible senior lecturer: Dr. Gábor Langer
Lecturer: Dr. Gábor Langer

The aim of the course: To introduce the basic concepts and laws of vacuum physics and technology. The course provides the basis for further studies in thin films and other fields of science and engineering.
Topics: Kinetic theory of gases. Flow of gases through tubes and orifices. Molecular flow. Continuum flow. Transitional flow. Gas release from solids. Positive displacement vacuum pumps. Oil-sealed pumps. Dry vacuum pumps. Kinetic vacuum pumps. Diffusion pumps. Molecular Drag and turbomolecular pumps. Capture vacuum pumps. Getters and getter pumps. Sputter ion pumps. Cryopumps. Vacuum gauges. Partial pressure analysis. Leak detection and leak detectors. High vacuum system design. Ultrahigh and extreme high vacuum.

Compulsory/Recommended Readings:

1. James M. Lafferty: Foundations of vacuum science and technology,_John Wiley and Sons, Inc. New York, 1998
2. John F. O Hanlon: A User s Guide to Vacuum Technology, John Wiley and Sons, Inc. New York, 1989

Subject: Analythical spectroscopic methods
Code: TFBE0412
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0
Prerequisite: TFBE0104
Type of exam: written and oral exam at the end of the semester
Responsible senior lecturer: Dr. Kökényesi Sándor
Lecturer: Dr. Kökényesi Sándor ,Dr. Szalóki Imre

The aim of the couse: Presentation of the basics and methods of analythical.
Topics: Quatum mechanical model of the hydrogen atom. The properties of the atomic states: energy, spin, angular momentum, magnetic moment, quantum numbers. Fine structure of the optical spectra, Zeeman and Starck effects, multielectron systems, Pauli principle, the periodic table of the elements. State equations, atomic transitions, Aguer effect, electron spectroscopy, electron spectroscopy. Electromagnetic radiation of atoms, absorbtion, stimulated emission, masers, lasers, their operation and applications. Basics of molecular physics, structure of molecular spectra, their explanation, Raman effect. Methods and instruments of atomic physics, particle accelerators, sources of electromagnetic radiation, x-ray tube, synchrotrons, energy and wave dispersive detectors. Structure determination methods based on atomic physics: ESR, NMR, CT, x-ray diffraction, x-ray absorbtion methods.

Compulsory/Recommended Readings:

1. Kiss Dezső, Horváth Ákos, Kiss Ádám: Kísérleti Atomfizika. ELTE Eötvös Kiadó, Budapest, 1998.
2. Litz József: Általános Fizika III., Könyvkiadó, 1998.
3. H. Haken and H. C. Wolf: Atomic and Quantum Physics.

Subject: Digital Image Bioengineering
Code: TFBE0415
ECTS Credit Points: 5
Lecture+practical+lab.practical courses/week: 2+3+0
Prerequisite: PIB17
Type of exam: oral or written exam
Responsible senior lecturer: Dr. Csaba Cserháti
Lecturer: Dr. Lajos Trón, Dr. László Balkay, Dr Miklós Emri, Dr Csaba Cserháti

The aims of the course: The course is going to provide mathematical and technical background of medical image manipulation and processing. It will introduce the physical principles, instrumental design, data acquisition strategies and image reconstruction techniques of different diagnostic tools like planar X-ray imaging, CT, MRI, Ultrasonic imaging, SPECT, PET.
Topics: Human and computer vision. Introduction to digital images: sampling, quantization, color images. Introduction to the image processing. Geometrical transformations, ROI, VOI analysis. Image enhancement: pixel brightness, local preprocessing, image restoration. Introduction to the principles of medical image aqusition equipments: X-ray equipment, CT, SPECT, PET, MRI, functional MRI, ultrasonic mapping systems, microscope techniques. Image forming from primer data of image aquisition systems: 2D, 3D backprojecting and other image reconstruction algorithms. Linear discrete image transforms (Fourier transform and filtering). Segmentation: tresholding, edge-based segmentation, region growing segmentation, matching. Multimodal image processing and image registration.

Compulsory/Recommended Readings:

1. Richard A. Robb (ed.): Biomedical Imaging, Visualization, and Analysis. Wiley-Liss (1999)
2. Andrew Webb: Introduction to Biomedical Imaging. John Wiley & Sons Ltd (2003)
3. Jerry Prince, Jonathan Links: Medical Imaging Signals and Systems. Pearson Education Inc. (2006)

Subject: Nuclear measurement techniques
Code: TFBE0413
ECTS Credit Points: 3
Lecture+practical+lab.practical courses/week: 2+0+0 (28 hours/semester)
Prerequisite: TFBE0104
Type of exam: written examination
Responsible senior lecturer: Dr. Zoltán Papp
Lecturer: Dr. Zoltán Papp, Dr. Zoltán Dezső, Dr. Eszter Baradács Erdélyiné

Aim of the course: To give an introduction into the measurement principles, technical equipment and measuring methods used in nuclear radiation measurements and radioanalysis.
Topics: Fundamentals (radioactive decay, types of nuclear radiation and their properties, cross section, interaction of charged particles and gamma-radiation with matter). Sources of nuclear and particle radiation (prepared sources of radioactive isotopes, particle accelerators, nuclear reactors, producing radioactive isotopes using cyclotron and nuclear reactor). Functioning and properties of detectors of nuclear radiation (gas-filled detectors, scintillation detectors, semiconductor detectors, other detector types). The rise of electronic signal and it's way from the detector to the signal processor (electronic equipment for the shaping and

analysing of signals). Principles and concepts of the procedures used in the quantitative analysis of the radiation (counting rate, connection between counting rate, source intensity and activity, background counting rate, counting efficiency, energy-discrimination, energy-spectra, identifying radioactive isotopes, activity measurement). Production, explanation and evaluation of energy-spectra. Comparison and characteristics of alpha-, beta- and gamma-spectra. Equipment, methods and application fields of alpha counting and spectrometry. The possibilities of the application of beta counting for analytic purposes. Equipment, methods and application fields of gamma-spectrometry. Equipment and methods for the measurement of neutrons. Methods of activation analysis (particle, neutron) and mass spectrometry.

Compulsory/Recommended Readings:

1. K. Sieghbahn: Alpha-, beta- and gamma-spectroscopy, North-Holland Publishing Company, Amsterdam, 1968.
2. NCRP: A handbook of radioactivity measurements procedures, National Council on radiation protection and measurements, Bethesda, 1994.
3. G. F. Knoll: Radiation detection and measurements, John Wiley and Sons, New York, 1979.

Subject: Demonstration Laboratory 1. (Mechanics)
Code: TFBL0101
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+2
Prerequisite: None
Type of exam: practical mark
Responsible senior lecturer: Dr. József Pálinkás
Lecturer: Dr.Judit Darai, Márta. Sántháné Koczka

Aim of the course: The objective of the course is to teach basic exprimental skills in mechanical measurements.
Topics: Kinematical evaluation of motions. Examination of free fall. Examination of impacts in air track and air table conservation of movement. Measuring force law of spring. Checking of independence of forces. Conditions of equilibrium. Static calibration of spring. Studying of vibrating systems.Torsion vibrations, the Steiner theorem. Measuring law of rotation.

Compulsory/Recommended Readings:

1. Szegedi S.-Demény A.-Dede M.: Demonstrációs laboratóriumi gyakorlatok (1.)
2. Szegedi S.-Demény A.-Dede M.: Demonstrációs laboratóriumi gyakorlatok (2.)

Subject: Demonstration Laboratory 2. (Thermodynamics and mechanics)
Code: TFBL0102
ECTS Credit Points: 1
Lecture+practical+lab.practical courses/week: 0+0+2
Prerequisite: TFBE0101
Type of exam: practical mark
Responsible senior lecturer: Dr. József Pálinkás
Lecturer: Dr.Judit Darai, Márta. Sántháné Koczka

Aim of the course: The objective of the course is to teach basic exprimental skills in thermodynamcal and mechanical measurements.
Topics: Experiments with wind tunnel. Studying of drag. The Stokes's law. The Archimedes' law. Examination of vibrations of chord, spring, wire loop Chladni's experiment. Measurement of sound speed. Introductory optical experiments: the law of reflexion and refraction, converging lens – image and object relationship. The Boyle-Mariotte's law. Studying of adiabatic processes for ideal gas. Clement-Desormes's method. Mechanical equivalent of heat. (Joule's experiment). Measuring the condensation heat of water. Measurement of speed of light by Foucault method.

Compulsory/Recommended Readings:

1. Szegedi S.-Demény A.-Dede M.: Demonstrációs laboratóriumi gyakorlatok (1.)
2. Szegedi S.-Demény A.-Dede M.: Demonstrációs laboratóriumi gyakorlatok (2.)

Subject: Demonstration Laboratory 3. (Electromagnetism)
Code: TFBL0103
ECTS Credit Points: 2
Lecture+practical+lab.practical courses/week: 0+0+2
Prerequisite: TFBL0102
Type of exam: practical mark
Responsible senior lecturer: Dr. Imre Szalóki
Lecturer: Dr. Imre Szalóki, Dr. Endre Takács

The aim of the course: Experimental study of basic phenomena of electromagnetism and to teach the basis of measuring methods and devices of the subject.
Topics: Electrostatic effects: measuring of electric charge and capacitance, structure of electric field. Electric current and electric resistance: Ohm's law and Joule's law. Kirchhoff's rules of electronic circuits. Temperature dependence of electric resistance. Electric properties of power supplies, batteries and solar cell. Thévenin's model for batteries. Structure of magnetic field of Helmholtz coils. Magnetic field and Lorentz-force. Impedances of capacitors and inductors. RC and LR circuits.

Compulsory/Recommended Readings:

1. Dr. Szalóki Imre, Demonstrációs Laboratóriumi Gyakorlatok. Debrecen, 2002.
2. D. Halliday, R. Resnick, J. Krane: Physics Vol. II., John Wiley & Sons Inc.
3. Sears, Zemansky, Young: University Physics, Addison-Wesley Publishing Company
4. D. Halliday, R. Resnick and J. Krane: Fundamentals of Physics, John Wiley & Sons Inc.

Subject: Demonstration Laboratory 4. (Atomic physics)
Code: TFBL0104
ECTS Credit Points: 2
Lecture+practical+lab.practical courses/week: 0+0+2
Prerequisite: TFBL0103
Type of exam: practical mark
Responsible senior lecturer: Dr. Imre Szalóki
Lecturer: Dr. Imre Szalóki, Dr. Endre Takács

The aim of the course: Experimental study of basic phenomena of electromagnetism and to teach the basis of measuring methods and devices of the subject.

Topics: Electronic oscillator, resonance effect in RLC circuits. RC filter circuits. Transformer. Properties of microwaves. Reflexion and polarization of light. Diffraction of light. Thermoelectric phenomena: Seebeck and Peltier effects. Determination of specific charge of the electron. Investigation of black-body radiation and Stefan-Boltzmann law. Photoelectric effect.

<u>Compulsory/Recommended Readings:</u>

1. Dr. Szalóki Imre, Demonstrációs Laboratóriumi Gyakorlatok. Debrecen, 2002.
2. D. Halliday, R. Resnick, J. Krane: Physics Vol. II., John Wiley & Sons Inc.
3. Sears, Zemansky, Young: University Physics, Addison-Wesley Publishing Company

D. Halliday, R. Resnick and J.