BULLETIN

Budapest University of Technology and Economics

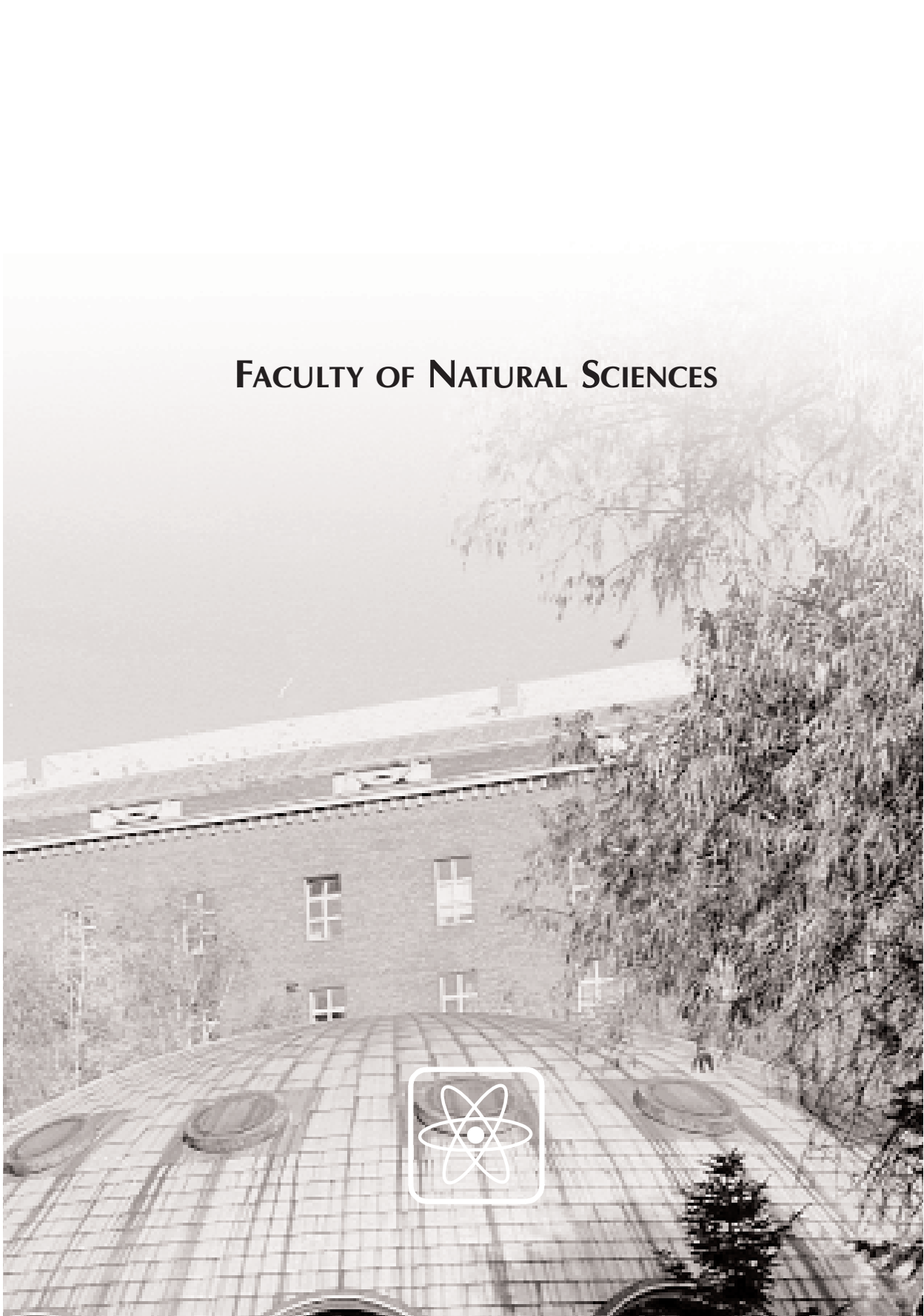
2006–2007

An ECTS Guide

Engineering Programs in English

http://www.tanok.bme.hu

Faculty of Natural Sciences

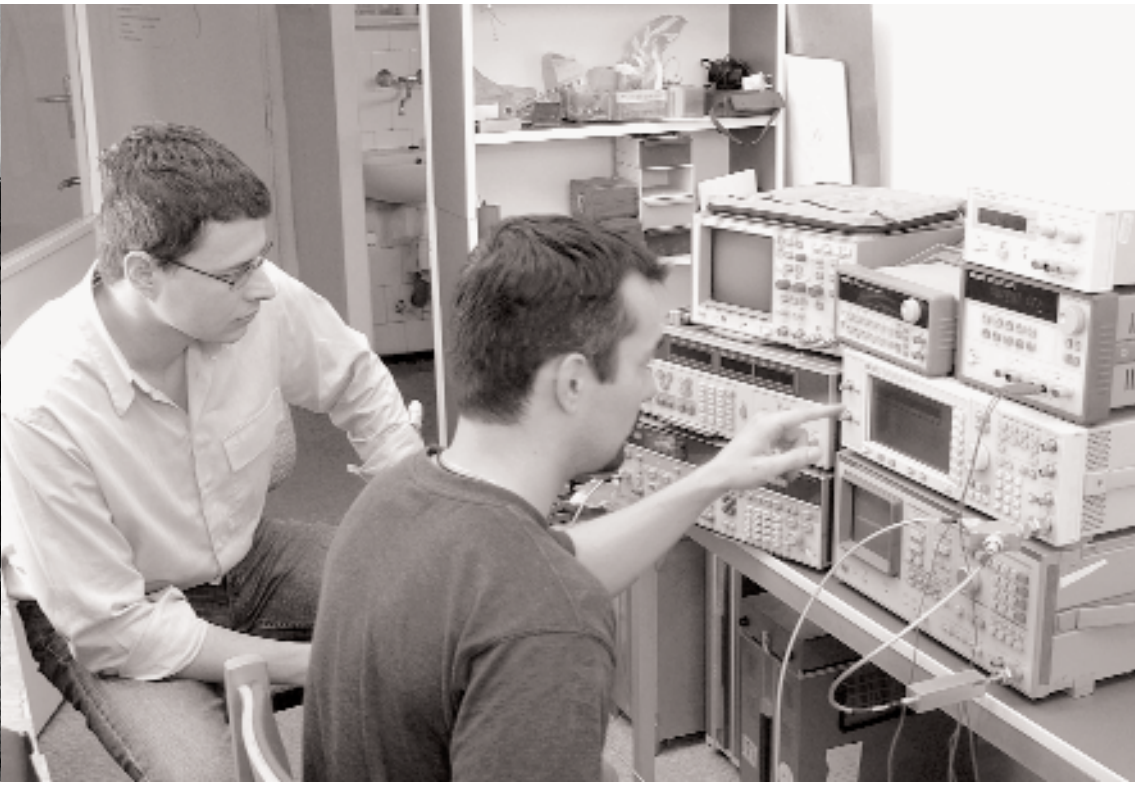


The Faculty of Natural Sciences, one of the newest faculties at the Budapest University of Technology and Economics, was established in 1998 and now employs 142 full and part time faculty members. The Faculty provides classes in mathematics and physics and designed to meet the needs of its own and other faculties.

Courses are offered on B. Sc. and M. Sc. degree levels. The faculty offers post-graduate scientific training. Currently more than 60 Ph. D. students are pursuing personal programs in different areas of sciences. The faculty also offers short courses on specific topics of current interest.

The faculty of Natural Sciences administers its own programs in engineering physics, applied mathematics and nuclear techniques:

- The Engineering Physics Program - a traditional continental curriculum that leads to M. Sc. degree in 10 semesters. The program provides comprehensive knowledge, built upon strong theoretical and experimental bases in four areas of specialisation (presently available in Hungarian only).
- The Applied Mathematics Program - a traditional continental curriculum that leads to M. Sc. degree in 10 semesters (presently available in Hungarian only).
- M. Sc. Program in Nuclear Engineering - four semesters of advanced-level instruction in reactor operations, nuclear power plant technology, nuclear measurement techniques, radiation and environmental protection, the application of radioisotopes and associated applied sciences.



Institutes

Institute of Mathematics
Departments of Algebra,
Calculus,
Differential Equations,
Geometry,
Stochastics,
Institute of Nuclear Techniques
Departments of Nuclear Techniques,
Nuclear Laboratory
Institute of Physics
Department of Atomic Physics,
Chemical Physics,
Experimental Physics,
Physics,
Theoretical Physics

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Dean of the Faculty: Prof. Dr. Tamás Keszthelyi
Vice-Dean of the Faculty: Dr. Csaba Sükösd, Dr. János Pipek, Dr. Béla Barabás, Dr. Márta Lázi
Course director of M.Sc. program in Nuclear Engineering: Dr. Péter Zagyvai

Engineering Physicist M.Sc. Program (Branch of Nuclear Techniques)

Subject		Credits / semester					Requisites
Name	**Code**	**0**	**1**	**2**	**3**	**4**	
Review Subjects (All Elective)							
Selected Topics in Mathematics I.	BMETKTEMX01	6					
Selected Topics in Chemistry	BMETKTEMX02	3					
Selected Topics in Physics	BMETKTEMX03	6					
Computing	BMETKTEMX04	5					
Informatics	BMETKTEMX05	3					
Measurement Theory	BMETKTEMX06	2					
Thermodynamics	BMETKTEMX07	4					
Electronics	BMETKTEMX08	4					
Measuring Techniques	BMETKTEMX09	4					
Process Control	BMETKTEMX10	4					
Fluid Mechanics	BMETKTEMX11	4					
General Subjects							
Selected Topics in Mathematics II.	BMETKTEM101		4				
Radiation Physics I.	BMETKTEM102		4				
Radiation Measurements I.	BMETKTEM103		6				
Radiation Protection I.	BMETKTEM104		4				
Signal Processing	BMETKTEM105		4				
Radiation Physics II.	BMETKTEM201			4			
Process Control Engineering	BMETKTEM202			4			
Special Subjects							
Production of Radioisotopes	BMETKTEM203			4			
Radioanalysis	BMETKTEM204			4			Radiochemistry
Industrial Application of Radioisotopes	BMETKTEM301				4		
Medical Application of Radioisotopes	BMETKTEM302				4		
Nuclear Detectors	BMETKTEM106		3				
Radiation Measurements II.	BMETKTEM205			4			Nuclear Detectors
Experiment Design and Data Analysis I.	BMETKTEM107		3				
Experiment Design and Data Analysis II.	BMETKTEM206			3			Experiment Design and Data Analysis I.
Nuclear Electronics I.	BMETKTEM108		3				
Nuclear Electronics II.	BMETKTEM207			3			Nuclear Electronics I.
Nuclear Material Testing Methods	BMETKTEM401					2	
Environmental Potection	BMETKTEM402					2	
Radiation Protection II.	BMETKTEM208			4			
Diagnostics	BMETKTEM303				3		
Nuclear Safety I.	BMETKTEM304				2		
Nuclear Safety II.	BMETKTEM403					2	Nuclear Safety I.
Quality Assurance	BMETKTEM305				3		
Radioactive Wastes	BMETKTEM306				4		Radiation Protection II.
Computer Program. in Radiation Physics I.	BMETKTEM209			2			
Computer Program. in Radiation Physics II.	BMETKTEM307				2		Computer Programming in Radiation Physics I.
Computer Tomography	BMETKTEM404					3	
Dispersion of Radiocontamination in the Environment	BMETKTEM405					3	Radiation Protection II.
Authority Regulations and Control	BMETKTEM406					2	
Reactor Physics	BMETKTEM210			8			
Reactor Materials	BMETKTEM308				2		
Reactor Technology	BMETKTEM309				3		Reactor Physics
Thermohydraulics	BMETKTEM211			3			
Nuclear Power Plants	BMETKTEM310				6		Reactor Physics, Thermohydraulics
Radiochemistry	BMETKTEM109		3				
Reactor Measurements	BMETKTEM311				3		Reactor Physics
Nuclear Power Plant Control Engineering	BMETKTEM312				4		
Nuclear Power Plant Operation	BMETKTEM407					3	Nuclear Power Plant Control Engineering
Nuclear Fuel Cycle	BMETKTEM408					2	
Siting of Nuclear Power Plants	BMETKTEM409					2	
Other Elective Subjects							
Hungary	BMETKTEM110		2				
Energetics	BMETKTEM212			2			
Non-Energetical Reactors	BMETKTEM313				2		
Accelerators	BMETKTEM314				2		
Nuclear Power Plant Management	BMETKTEM410					2	
Engineering Ethics	BMETKTEM411					2	
Project work	BMETKTEM315, BMETKTEM412				6	24	

Description of M.Sc. Program In Engineering Physics (Branch of Nuclear Techniques)

This program offers four semesters of advanced level instruction in radiation physics, radiation measurement techniques, radiation and environmental protection and the application of radioisotopes in different areas of interest as well as in nuclear engineering. A one semester review course that starts each February is available for students who need to refresh their knowledge before beginning M.Sc. level studies. The review course offers a wide spectrum of engineering subjects on the B.Sc. level. The general curriculum courses are compulsory for all students while the specialised subjects are elective. The number of credits students can obtain in a semester is recommended as not less than 30. Individual work is highly encouraged and a significant proportion of the students' activities is based on individual study. The thesis must be completed by the end of the fourth semester. The activity devoted to its preparation is termed "project work" with an aggregate credit value of 30. A total number of at least 120 credits is a must for the final examination. Students who achieve excellent results have the possibility to continue to work toward their Ph.D. degree on an individual basis. For more information, please contact the Course Manager, Dr. Péter Zagyvai. Tuition fee: 4000 EUR per semester.

SUBJECTS: Review subjects, General subjects, Special subjects.

Review Subjects (All Elective)

Selected Topics in Mathematics I

BMETKTEMX01

Gabriella Szép

Fundamentals of classical univariate and multi-variate analysis; definition and the laws and procedures of problem solving. Introduction to linear algebra. Simple types of integrable common differential equations. Fundamentals of classical probability theory. Combined solutions of problems. (6 credits)

Selected Topics in Chemistry

BMETKTEMX02

Péter Zagyvai

Atomic nuclei. Periodic table of elements. Chemical substances and reactions. Physico-chemical characteristics of materials in various phases. Fundamentals of chemical thermodynamics and reaction kinetics. Electrolysis, electrolytic fluids. Corrosion and the prevention of corrosion. Structure of solid state materials. Metals and alloys. Fundamentals of water and environmental chemistry. (3 credits)

Selected Topics in Physics

BMETKTEMX03

Éva Zsolnay

The laws of classical physics. Fundamentals of the theory of relativity. Electromagnetic fields and electromagnetic waves. Introduction to thermodynamics and statistical physics. Fundamentals of quantum mechanics and their applications. (6 credits)

Computing

BMETKTEMX04

Szabolcs Czifrus

Basic structure of computers. Description of logical interfaces. General sequence for solving tasks by programming. Rules of algorithms. Elaboration of flow charts. Groups of programming languages. Fundamentals of PASCAL. Solutions of characteristic programming tasks. (5 credits)

Informatics

BMETKTEMX05

Sándor Fehér

Applications of Computing. Computer peripherals and their applications. Structure of local and remote computer networks; their operation. Informatics systems. Types of software applications. (3 credits)

Measurement Theory

BMETKTEMX06

Péter Zagyvai

Fundamentals of probability theory and mathematical statistics. Description of distributions. Definition of measurement uncertainty and error. General rules of generating indirect measurement data, bases of error propagation. Measurement errors for nuclear detector pulse counting. Methods of estimation. Definition of confidence levels. Statistical evaluation of outlying results. (2 credits)

Thermodynamics

BMETKTEMX07

Attila Aszódi

Bases of technical thermodynamics. Stationary and transient heat transmission. Heat transfer and heat transmission in heat exchangers. Heat radiation. Thermodynamic systems. Principal laws of thermodynamics. Thermal partition functions. Changes of state. Cycle processes. Gas-vapour mixtures. (4 credits)

Electronics

BMETKTEMX08

Gábor Pór

Physical fundamentals of the operation of electric devices and equipment. Electric circuits and meters; electric machines. Transformers, energy transformers, and engines. Performance electronics. Operational characteristics of the electric drive. Electric networks and generators. Effective and ineffective performance. Cables. Energy transfer. Substations, consumption groups and ineffective performance electronics. Electric shock prevention. (4 credits)

Measuring Techniques

BMETKTEMX09

Gábor Pór

Basic terms of metrology. Measurement of pressure and pressure difference, mass and volume and level heights. Measurement of velocity and flow rate, one- and two-phase measurements. Bias of measurement. Contemporary techniques of information transformers. Data analysis, data processing. Modelling principles. Operational principles and structures of detectors, sensors and measuring loops. (4 credits)

Process Control

BMETKTEMX10

Gábor Pór

Fundamentals of process control. Linear dynamic elements in the time and frequency domains. Differential equations of dynamic elements, frequency and transmission functions. Resultant descriptive functions of related elements. Controllers; their descriptive functions and tuning parameters. Closed control loops. Optimal tuning of controllers. Characteristics controlling connections, design of control loops. Hardware for process control. (4 credits)

Fluid Mechanics

BMETKTEMX11

Attila Aszódi

Physical properties of flowing substances; Euler and Lagrange descriptions. Transport equation, continuity, equation of motion, field-function turbine equation, Zhukovskii theorem and free jet radius. Measuring orifice and Venturi tube. Turbulence. Similarity of numbers. Boundary layer, flow separation and the force operating of bodies. Flow of compressible substances in piping. Laval tube and perpendicular and oblique shock waves. Wave equation, acoustic power and acoustic pressure. Eddy theorems. Hydrodynamic engines; summary of their operational characteristics. (4 credits)

General Subjects (compulsory)

Selected Topics in Mathematics II - Numerical Methods

BMETKTEM101

Gabriella Szép

Probability, variable and distribution functions. Expected value, scattering, co-variance and the correlation coefficient. Linear regression. Distribution of statistical functions; estimation of parameters and intervals, statistical probes. Vector analysis. Isometric tensor orthogonal base transformation. Diagonal law of symmetrical tensors. Resolution of tensors, tensor analysis. Invariants of derived tensors and vectors. Laws of integral transformation. Common differential equations. Laplace transformation. Partial and secondary differential equations. Methods of interpolating function approximation. Numerical methods for differentiation and integration. Optimum criteria. Orthogonal base functions. Approximate solutions of equations and equation systems. Direct and iterative solutions of linear equation systems. Eigenvalues and eigenvectors of quadratic matrices. Approximate solutions of differential equations: successive approximation, partial sums of series functions and finite differences. (4 credits)

Radiation Physics I (Nuclear Physics)

BMETKTEM102

Csaba Sükösd

Characteristics of stable atomic nuclei. Models of nuclear structure. Laws of radioactive decay. Nuclear reactions. Nuclear radiations. Fundamentals of particle physics. Laws of absorption and excitation. Interactions of radiation with matter. Radiation attenuation. (4 credits)

Radiation Measurements I

BMETKTEM103

Dénes Bódizs

Types and operation of nuclear detectors. Components and general structure of measuring devices. Alpha-, beta-(electron-), gamma-, neutron- and X-ray spectroscopy. Liquid scintillation measurements. Moessbauer spectroscopy. Absolute activity measurements. Coincidence effects and techniques. Background reduction. Error analysis. Methods of data processing. (6 credits)

Radiation Protection I

BMETKTEM104

Péter Zagyvai

Units of dosimetric terms. Biological effects and risk of ionising radiations. Dose limitation - bases and regulations. Sources of radioactivity in the environment. The radon problem. Equipment of dose and dose rate measurements. Operational and personal dosimetry. Methods of decontamination. Radiation shielding. (4 credits)

Signal Processing

BMETKTEM105

Gábor Pór

Most common digital circuits. Operational amplifiers. Design of basic analogue and digital circuits. Digital/analog converters. Sampling. Deterministic and stochastic signals. FFT technique. Autoregression. Neural network, fuzzy logic. Wavelets. (4 credits)

Radiation Physics II

BMETKTEM201

Éva Zsolnay

Features of neutron gas. Transport theory. Diffusion equations. Multiplication and reactivity factors. Slowdown and thermalization of neutrons. Reactor neutron spectra. Resonance integral. Core moderation. Reactor kinetics, burnout and poisoning. Radiation attenuation. Monte Carlo calculations and cross-section libraries. (4 credits)

Process Control Engineering

BMETKTEM202

Gábor Pór

Multivariate dynamic systems. Methods of system identification. Transmission matrix. State space model. Relationship between observation and control. Structure optimised control. Elements and operation of up-to-date process control systems. (4 credits)

Special Subjects (elective)

Production of Radioisotopes

BMETKTEM203

Nóra Vajda

Preparation of targets. Nuclear reactions induced by neutrons and charged particles. Methods of irradiation. Production rates. Chemical processing. Separation and purification technologies Processing of fission products. Radio nuclide generators. Units and facilities of processing. Sealed sources. Labelling organic compounds. Quality control. Packaging and transporting radioactive shipments. Waste disposal. (4 credits)

Radioanalysis

BMETKTEM204

Zsuzsa Molnár, Nóra Vajda

Identification of natural and artificial radioisotopes. Determination of alpha, beta and gamma-emitting nuclides. Analytical procedures for iodine, caesium, strontium and transuranic alpha emitters. Neutron- and gamma-activation analysis. Basic principles of neutron absorption and nuclear reactions. Methods and practice of standardisation: relative method, absolute method, application of k- and k0-factors. X-ray fluorescence analysis. Isotopic dilution. Radiometric titration and radio chromatography. (4 credits)

Industrial Applications of Isotopes

BMETKTEM301

Péter Zagyvai

Characteristics of radioisotopes and radioactive preparations. Free and closed sources. Nuclear measuring devices applied in industry. Classical methods for indicating physical parameters: measurement of level height, thickness, density, mass and volume rate. Measurements of chemical composition. Principles of tracer techniques. Detecting leaks, checking unit operations and tracing reaction kinetics. Activation and dilution radio analysis for quantification. Nuclear borehole geophysics. Gamma and electron irradiation technologies for polymerisation and sterilisation. Industrial radiography. (4 credits)

Medical Application of Isotopes

BMETKTEM302

József Környei

Principles of radio-immunoassay (RIA). Production and separation of tracers. Separation of antibody-bound and free antigens. Principles of immuno-radiometric assay (IRMA). Solid- phase antibodies. Monoclonal antibodies and two-site IRMA. Fitting standard curves of RIA and IRMA; statistical aspects and evaluation. New radioisotopic immunoassays. (4 credits)

Nuclear Detectors

BMETKTEM106

Dénes Bódizs

Characteristics of nuclear radiation. Interactions of nuclear radiation with matter in nuclear detectors. Ionisation chambers, proportional counters, and GM tubes. Scintillation detectors. Semiconductor detectors. Gamma and charged particle spectrometry. Neutron detectors. Neutron spectrometry. Preamplifiers for detectors. Noise of detector-preamplifier systems. Pulse-shaping amplifiers, baseline restorers, live-time corrections, and pulse-shape discriminators. Information selection and storage. Counters and rate meters.(3 credits)

Radiation Measurements II

BMETKTEM205

Dénes Bódizs

Alpha, beta, gamma, neutron and x-ray spectrometry. Measurement of absolute activity; event and time-coincidence techniques; liquid scintillation and background reduction. Corrections for dead-time losses, true and random coincidence, attenuation and self-absorption. Determination of nuclear reactor parameters applying stochastic and deterministic signals. Comparison of nuclear and non-nuclear measuring procedures. (4 credits)

Experiment Design and Data Analysis I-II

BMETKTEM107 BMETKTEM206

Zoltán Szatmáry

Fundamentals of mathematical statistics. Characteristics of discrete distributions. Methods of parameter estimation. Statistical probes. Correlation between probability variables. Laws of error propagation. Variance analysis. Statistical weights. Nuclear data types, validity of nuclear statistics. Sources of measurement errors. Confidence criteria in nuclear measurements. Regression procedures, examination of model functions. Linear, linearised, multivariate and non-linear regression. Regression with implicit functions. Data transformation methods. Examination of residuals. Fundamentals of designing experiments. Advance prediction and detection limits. (3+3 credits)

Nuclear Material Testing Methods

BMETKTEM401

Ferenc Lévai

Fundamentals of radiological methods. Gamma and neutron radiation sources. Image detection methods, data processing. Characteristics of nuclear materials, measuring the characteristics by radiology and image detection. Examination of nuclear fuel. (2 credits)

Environmental Protection

BMETKTEM402

György Pátzay

Environmental effects of generating energy: coal, gas and oil-fuelled power plants, nuclear power plants, hydropower stations. Alternative energy production and environmental problems. International organisations dealing with environmental protection. (2 credits)

Radiation Protection II

BMETKTEM208

Péter Zagyvai

Terminology of dosimetry. Dosimetric quantities and principles for their determination. Relationship between dose quantities. External and internal radiation exposure. System of dose limitations. Dose exposure from natural and artificial radioisotopes. Measurements and measuring devices in radiation protection and dosimetry. Radioactive substances in the environment and in living organisms. (4 credits)

Diagnostics

BMETKTEM303

Gábor Pór

Stochastic noise sources in nuclear establishments. Statistic characteristics of noise signals. Noise analysis in time and frequency domains. Objectives of diagnostics by equipment. Analysis of neutron flux, pressure fluctuation, oscillation and acceleration. Using acoustic noise signals to monitor vibration and detect boiling, leakage and detached parts. Diagnostic systems for noise. Analogue measuring channels and central processors. (3 credits)

Nuclear Safety I-II

BMETKTEM304 BMETKTEM403

Sándor Fehér, Szabolcs Czifrus

Principles of nuclear safety. Causes of breakdowns, the process, human and automatic interventions. Structure and analysis of safety systems. Fundamentals of safety design; methods of dimensioning; reliability analyses. Methods of calculation in safety design. Novel methods of safety analysis. Fundamentals of reliability theory and methods of calculation Evaluation of risk studies. Safety criteria. Accident prevention. Safeguards. Safety of the critical state for storing nuclear fuel and other nuclear materials. (2+2 credits)

Quality Assurance

BMETKTEM305

László Balázs

Fundamental terms of quality assurance and metrology: the ISO 8402 and VIM. The paradigm of quality. International standardisation. The process of standardisation. The ISO system - the European way. Statistical methods in QA. Statistical process control, control charts. Other QA systems and philosophies. The philosophy of Total Quality Management and the most important management methods. Quality costs, life cycle costs. The basic units of the SI system. Statistical process control. Measuring ability and calibration uncertainty of a laboratory. Expression of uncertainty in measurements, extended uncertainty of measurements. (3 credits)

Radioactive Wastes

BMETKTEM306

Péter Zagyvai

Categories of radioactive waste. Methods and procedures of qualification. Sources of radioactive waste. Steps of management: collection, selection, volume reduction, conditioning, transportation, temporary storage and final disposal. Possibilities of reutilization of wastes. Environmental remediation. (4 credits)

Computer Programming in Radiation Physics I-II

BMETKTEM209 BMETKTEM307

Sándor Fehér, Szabolcs Czifrus, Péter Zagyvai

Applications of Monte Carlo (MC) programming in radiation physics: Generating random numbers. The linear multiplicative congruential method. Period of a random number sequence. Testing methods of random generation. Techniques for random sampling. Density and distribution functions. The top hat method. The inverse cumulative function method. The rejection technique. Variance reduction techniques. The method of survival weights. The statistical estimator method. Russian roulette. The method of splitting. Applications of MC codes. Programming in nuclear spectrometry: Data acquisition and data evaluation programs in alpha- and gamma-spectrometry. Requirements of qualitative and quantitative analysis. Estimation of sensitivity and uncertainty. Prediction programming. (2+2 credits)

Computer Tomography

BMETKTEM404

Ferenc Lévai

Imaging with gamma-photons: modulation effects, information and properties. Image description: resolution, contrast sensitivity, signal-to-noise characteristics. Imaging detector models and their required properties. Scanner arrangements. Measurement of line integral and projection. Basic algorithms for image reconstruction from projection. (3 credits)

Dispersion of Radiocontamination in the Environment

BMETKTEM405

Péter Zagyvai

Dispersion of radiocontamination in homogeneous media: migration in air, dispersion in surface waters. Formulation, the role of modelling and prediction. Migration of radiocontaminants in multiphase systems: migration in groundwater and geological media, immission, retention and excretion of radioactivity in biological systems. Formulation and modelling. Procedures of dose estimation. Monitoring and validation of models. (3 credits)

Authority Regulations and Control

BMETKTEM406

Ildikó Czoch

Principles and strategies of safety. Responsibility of operating organisations Safety standards and practice. System of independent supervision. Legal opportunities. Directive organisations. Regulations and guides. Licensing and regulatory review process. Regulatory inspection and enforcement. Hazard preparedness. Role of international organisations and their activities. (2 credits)

Reactor Physics

BMETKTEM210

Éva Zsolnay

Neutron gas investigation methods. Transport theory. Approximate solutions of transport equations. Diffusion equations. Critical systems. Multiplication factor. Reactivity. Slowdown theory for neutrons. Neutron thermalization. Reactor neutron spectra. Multiplication factor for heterogeneous reactors. Resonance integral. Doppler phenomena. Reactivity factors. Over moderated and under moderated core. Reactor kinetics. Burnout and multidimensional burnout codes. Reactor poisoning Xenon oscillation. Slowdown and thermalization codes. Measurement of reactivity; flux and spectral index. Radiation attenuation in mixed gamma- neutron radiation space. Kernel integration, spherical harmonics, and the Pl-approximation. Monte Carlo calculations. Cross-section libraries. (8 credits)

Reactor Materials

BMETKTEM308

Attila Aszódi

Structural steel and other traditional materials. Characteristics of materials in terms of operational safety, related physical processes and quantities indicative of fatigue failure. Special structural materials. Physical properties of fission materials and their influence on structural design. Corrosion processes in structural materials. (2 credits)

Reactor Technology

BMETKTEM309

Gábor Bede

General structure of energetic nuclear reactors. Types of nuclear energetic reactors. Fuel, control devices, other structures in the reactor core and the reactor vessel systems. Structures in the primary cycle. Cooling technologies. (3 credits)

Thermohydraulics

BMETKTEM211

Attila Aszódi

Homogeneous and slip flow. Critical and two- phase flow. Characteristics of heat exchange. High-volume source and the critical heat flux. Flowing source. Two-phase measurements. Thermodynamic codes. Experiments using the resources of the training reactor of the Institute of Nuclear Physics. (3 credits)

Nuclear Power Plants

BMETKTEM310

Gábor Bede

Energy production. Types of power plants. Loading control. Nuclear power plants in electric generation. Structure of nuclear power plants. Devising the heat scheme. Nuclear power plant equipment and supplementary systems. Architecture and layout. Siting nuclear power plants. Nuclear heat production and nuclear heating. (6 credits)

Radiochemistry

BMETKTEM109

Nóra Vajda

Nuclear reactions. Interactions between radioactive particle beams and matter. Radioactive labelling and tracer techniques. Chemistry of ultra low concentrations. Hot atom chemistry. Isotope effects. Chemistry of uranium. Manufacturing nuclear fuel. Technologies for reprocessing nuclear fuel. Chemistry of nuclear power plants and research reactors. Production of isotopes. (3 credits)

Reactor Measurements

BMETKTEM311

Sándor Fehér

Experiments in reactor physics and reactor operation using the training reactor and laboratories of the Institute of Nuclear Techniques. (For details see description of Radiation Physics II and Reactor Physics) (3 credits)

Nuclear Power Plant Control Engineering

BMETKTEM312

Attila Aszódi

Principles of nuclear steam generating systems. Automatic reactor control. Automatic power level control (open-loop, closed-loop). Dynamic mathematical models. Other control systems. Control of turbines in nuclear power plants. Speed and power control Procedures and tools of power changing. Dynamic processes in turbines during start up; the reduction of loading. Improving turbine control methods. Turbine control and protection systems. (4 credits)

Nuclear Power Plant Operation

BMETKTEM407

Gyula Csom

Operational characteristics of nuclear power plants: performance distribution and inequality, reactivity factor, self-controlling incapability, xenon poisoning and oscillation fuel burnout. Change of reactor characteristics during burnout. Duration of operational campaigns. Fuel cladding leaks. Reactor vessel control. Rearrangement of fuel elements. Nuclear reactor as a radiation source. Steam generators and saturated steam turbines. Nuclear reactor blocks: manoeuvring ability and the variability of loading. (3 credits)

Nuclear Fuel Cycle

BMETKTEM408

Sándor Fehér

Uranium ore mining and conversion. Isotope enrichment. Manufacturing fuel elements. Burnout in the reactor. Reprocessing irradiated fuel. Waste management and final deposition. Uranium-plutonium cycle, thorium cycle, open-loop and closed-loop cycles. Efficiency of uranium utilisation. Nuclear power plant systems. Symbiotic system. Regional nuclear energy systems. (2 credits)

Siting of Nuclear Power Plants

BMETKTEM409

Gyula Csom

Selecting sites for nuclear power plants. Geological and seismological requirements. Regulations and recommendations. Technical and economic considerations and investigations. Steps in plant siting: preparatory activities, investment proposals, permission procedures and public relations. (2 credits)

Other Elective Subjects

Hungary

BMETKTEM110

András S. Szőllősy

Brief summary of Hungarian history. Geographic and ethnographic connections between Middle-European nations. Geographic regions of Hungary. Economic structure of Hungary. Social organisations and political events of the past decades. Overview of Hungarian culture. (2 credits)

Energetics

BMETKTEM212

Tamás Jászai

Energy resources; natural and anthropogeneous energy fluxes. Interrelation of energy, economy, environment and society. Transformation matrix of sources and requirements. Technical, economical and environmental parameters of basic energy transformation technologies. Centralised and local energy supply alternatives. Developments toward low energy consumption. Strategies for developed and developing countries. Technical and economic aspects of reasonable energy use. (2 credits)

Non-Energetical Reactors

BMETKTEM313

János Gadó

Zero reactors. Processes in zero reactors with respect to nuclear safety. Measurements on zero reactors. Research reactors. Safety aspects and applications of research reactors. (2 credits)

Accelerators

BMETKTEM314

Csaba Sükösd

Operation of accelerators. Optics of particle beams. Low energy static and cyclic accelerators. Acceleration in the relativistic domain. Secondary radiation sources. Accelerators in material science, technology, diagnostics and medial science. (2 credits)

Nuclear Power Plant Management

BMETKTEM410

István Bakács

Economics of nuclear power plants. Nuclear power plants in energy generating systems. Nuclear power project. Education and training of personnel for nuclear power plants. Establishment and investment. Maintenance of nuclear power plants. Experiences of the Paks nuclear power plant in Hungary. Activities of the International Atomic Energy Agency. (2 credits)

Engineering Ethics

BMETKTEM411

László Molnár

Ethical problems of the technical civilisation. Moral aspects of engineering activities. Pure rationalism of engineering. Case studies. Analysis of codes of engineering ethics. Role of engineering organisations in protecting ethical principles. Jurisprudence and moral principles. Morality and societal control of technologies. (2 credits)

Project work

BMETKTEM315, BMETKTEM412

An individual project work is elaborated by each student finalising his/her studies. Topics are offered by supervisors and approved by a specific Faculty Board. The acceptance of the project work is a requisite of the M.Sc. diploma. The paper should contain a literature survey and the description of the theoretical and/or practical work of the student. (6 + 24 credits)