

BIALYSTOK TECHNICAL UNIVERSITY – FACULTY OF ELECTRICAL ENGINEERING
Field of study: ELECTRONICS AND TELECOMMUNICATIONS

Core subjects for all specializations

Subject	Code	Points/ ECTS	Number in semester of hours	<i>Core syllabus</i>
First Semester				
MATHEMATICS 1	W01 001	9	105	Complex numbers. Algebraic equations. Boolean algebra. Linear spaces and their bases. Linear mapping. Matrix calculus. Systems of linear equations and methods of solving them. Eigenvalues and eigenvectors. Lines and planes in linear spaces. Elements of the graph theory. Limitations of sequences and functions. Continuous functions. Differential and integral calculus of one real variable. calculus of one real variable.
PHYSICS 1	W01 002	7	75	Theory of relativity. Oscillating motion and wave motion. Wave theory of light. Quantum theory of electromagnetic radiation. Atomic physics. Wave properties of particles.
INTRODUCTION TO COMPUTER SCIENCE 1	W01 003	4	45	Analog and digital form of information. Measures of digital information. Numerical form of numbers: natural codes, binary code, binary-decimal codes, Grey's code. Basic arithmetic operations in binary code. Bool's algebra. Low-level data representation in computers (integer and floating-point numbers). Basic arithmetic operations (addition, multiplication, subtraction) with integer or floating-point numbers. Errors, range and precision of operations and digital representation. Character codes (ASCII, ISO-8850, Unicode). Algorithms: basic terms, design, and analysis. Notations of algorithms (pseudocode, graph, flow-chart). Programming languages, properties and form of low level and high level languages. Introduction to programming in C/C++: <ul style="list-style-type: none"> ○ concept of data type, standard and user-defined scalar types. ○ simple statements, arithmetic and boolean expressions, assignment statements, simple input and output commands (console and files). ○ repetitive commands, conditional statements, conditional and unconditional branching. ○ data structures: single and multidimensional arrays, character strings, structures. ○ general concept of functions, declaration and calls of functions, parameters. Laboratory exercises include extensive programming in the C/C++ language and experimenting with and analyzing software systems
FUNDAMENTALS OF CIRCUIT THEORY 1	W01 004	4	45	Basic concepts of electric circuits. Passive and active circuit elements, ideal and real sources. Source transformation. Electric signals. Ohm's law. Kirchhoff's current and voltage rules. Superposition principle. Analysis of DC circuits. AC analysis of RLC circuits: concepts of complex numbers and phasors; mathematical operations with complex numbers; rectangular and polar phasor forms of impedance - resistance, capacitive reactance and inductive reactance. Power in AC circuits. Resonant circuits.

GEOMETRY AND ENGINEERING GRAPHICS	W01 005	4	60	The orthogonal, axonometric projection, the layout of projections. Sections and views, and their application in construction. Basic principles of dimensioning. Accuracy classes of work. The surface state. Dimensional tolerance. The drawing of selected constructional elements. The assembly drawing. Diagrams. Drawing in electrical and civil engineering. Auto-CAD – fundamentals of the digital construction recording.
Second Semester				
PHYSICAL EDUCATION 1	W02 006	0	30	
MATHEMATICS 2	W02 007	6	60	The number and function series. Complex functions. The Laplace and 'Z' transform. Functions of several real variables. Integrable ordinary differential equations of the first order. Linear ordinary differential equations of higher orders (homogeneous and non-homogeneous). The application of the Laplace transform to differential equations.
PHYSICS 2	W02 008	2	15	Students carry out 13 laboratory experiments in the field of mechanics, electricity, thermal process and optics. Students take measurements, do calculations and prepare reports.
APPLICATION SOFTWARE	W02 009	2	30	The aim of this subject is acquaintance students with the basic application software, which they will use during studies. Work in Windows environment. Standard applications: word processors, spreadsheets, formation and management of databases, graphical, mathematical and computational software. Co-operation between applications and interchange of data.
ANALOG TECHNIQUES 1	W02 010	6	60	1. Magnetically coupled circuits, 2. Four-terminal networks, 3. Systems with distorted (non-harmonic) currents, 4. Transient states in electrical circuits.
OPERATING SYSTEMS	W02 011	4	45	Course description: <ul style="list-style-type: none"> o Computer organization. Von Neumann architecture. Harvard architecture. o Definition, history, organization and common properties of OS. Basic terminology. Basic functions and sub-components of OS. o Resources abstractions in OS. Resources sharing. Device management. o Process management. Process modes. Process description. Life cycle of the process. Different process management strategies. o Memory management. Memory hierarchy. Caching. Virtual memory. Segmented virtual memory. o File management. Physical and logical structure of the disk. Different file management strategies (sequential, indexed, direct, networked). Structure of file system (Unix-like, Windows: FAT and NTFS). o Network Utilities in OS. o Protection and security in OS - basic concepts. o Kernel and shells in OS. Laboratory exercises include some tutorials and experiments with Linux and Windows OS.
METROLOGY 1	W02 012	3	30	Fundamental problems of metrology. Elements of the error theory. General methods of measurements and examples of their realization. Digital methods of measuring electrical quantities. Digital measurement systems. Measurements of non-electrical quantities.
DIGITAL TECHNIQUES 1	W02 013	4	45	Recording information in a digital system. Methods of minimizing Boolean forms and the synthesis of combination systems. Designing sequential systems.

SAFE OPERATIONAL USE OF ELECTRICAL DEVICES	W02 014	1	15	<p>Major concept of the safe work organization with technical devices. Modern origin of the accident and illness prevention. Management in the accident prevention. National standards, statutory regulations, codes of practice, official guides and circulars in safety and coordination aspect. Work condition monitoring. Concept of risk definition. Risk modelling and analyzes.</p> <p>Danger in using electric devices – static electricity, electric shock, fire and explosive hazard, influence electromagnetic field. Current effect on human body. Interrupting and rescuing from electric shock effect. Electric after shock investigation. Safe work organization in using electric devices. Sate, firm and manager safety obligations. Human qualification for exploitation electric power systems. Worker safety duties in electric power system exploitation.</p> <p>Technical methods to ensure of electrical safety. Protection against electric shock in low and high voltage devices. Protection against fire, explosive and influence electromagnetic field. Legal regulations. Personal safety equipment and working tools and their using. Work under voltage.</p>
Third Semester				
PHYSICAL EDUCATION 2	W03 015	0	30	
ELECTRONIC MATERIALS AND ELEMENTS	W03 016	3	45	Structure and defects in crystal and amorphous materials. Electrical conducting and physical parameters of dielectrics and semiconductors. Semiconductors technology, thin layers, fibres, coating layers. Superconductors, electrical carbon, contact materials. Nano crystal materials, sensor elements, supercapacitors, ferroelectrics. Magnetic materials end elements. Recycling in electronics. Clima, reliability standards in electronic elements.
ELEMENTS OF OPTOELECTRONICS 1	W03 017	2	30	Optical fibres. Optical fibre cables and joints. Radiation sources and detectors. Solid ionic lasers. Optical modulators. Insulators and optical circulators. Radiation amplifiers. Coupling radiation sources and photo detectors with optical fibres. Micro-optical elements. Elements of integrated optoelectronics
APPLICATIONS OF COMPUTERS 1	W03 018	4	60	Computer aided design for electronics engineers. Mathematical modeling of electronic elements and circuits. Lumped-circuit modeling of heat exchange. Interpolation and approximation. Analysis of branched linear electronic circuits. Indeterminate matrix of circuit admittances. Methods of numerical solution of linear and nonlinear systems of equations. Numerical methods of solution of systems of ordinary differential equations of first order. Spectrum analysis - DFT and FFT. Selected methods of optimization. Numerical integration.
ANALOG TECHNIQUES 2	W03 019	3	30	The RLC circuits. Magnetically coupled circuits. The transmission line with inductance and capacitance. Selective circuits. Four-terminal circuits. Transient states. Non-linear resistance circuits. Introduction to Pspice. The spectral analysis of electrical circuits
SEMICONDUCTOR DEVICES 1	W03 020	3	30	Physical properties of semiconductors. Principles of operation, characteristics, properties, models and chosen applications of semiconductor devices such as diodes, transistors and optoelectronic elements. The operational amplifier.
METROLOGY 2	W03 021	3	30	General methods of measurements. DC measuring bridges. The impact of a measuring instrument on the examined object. Technical methods of inductance and capacitance measurements. The electronic oscilloscope. Digital methods of measuring basic electrical quantities.
DIGITAL TECHNIQUES 2	W03 022	4	45	Internal structures, functions and basic parameters of integrated digital systems. Methods of synthesis and computer system designing in programmable PLD and FPGA structures.
INTERFERENCE PROTECTION 1	W03 023	3	30	Sources of disturbances. Overvoltages and overcurrents in power supply nets and signal lines, electrostatic discharges. Radiated interferences. Measurements and simulations of interferences. Traveling waves in lines. Gas arresters, waristors and protective diodes. Filters. Protection against disturbances in power supply nets and signal lines. Shielding, rounding and bonding.

NON-ELECTRICAL QUANTITIES MEASUREMENTS 1	W03 024	3	30	Metrological properties of measurement instruments. Measurements of mechanical quantities; mechanical to electrical quantities transducers. Temperature measurements: temperature scales; glass, pressure, thermoelectrical, optical thermometers. Measurements of physicochemical quantities. Electromagnetic radiation spectrum and its application in non-electrical quantities measurements. Spectrophotometry and absorption photometry UV-VIS-IR, flame photometry and nuclear absorption photometry. Conductometric measurements, ion activity measurements, field-effect transistors (FETs) as chemical quantities transducers.
Fourth Semester				
TECHNOLOGY WORKSHOP 1	W04 025	1	15	Practical design techniques for the laboratory models, prototypes and small production series. Design of the simple electronic circuit. Project and production of the PCB for designed electronic circuits. Tools, materials and chemicals products in the PCB production. Montage and testing of the designed circuits.
TELECOMMUNICATIONS SYSTEMS AND NETWORKS 1	W04 026	3	30	A historical review of telecommunications systems. Main components of a telecommunications network. General foundations of telecommunications and computer network architecture. Open systems interconnection reference model (OSI), layered protocols. Network equipment: hubs, switches, routers, modems, gateways etc. Main and auxiliary network protocols: IP, TCP, UDP, ICMP, ARP, DHCP, DNS and others. Local area network (LAN) technologies and architectures: Ethernet, Fast Ethernet, Gigabit Ethernet. Wide area (WAN) and metropolitan area (MAN) network technologies: ATM, Frame Relay, X.25, ISDN, Metro Ethernet. Internetworking routing. Interior and exterior routing protocols: RIP, BGP. Internet architecture. Domain name system (DNS). Intelligent buildings.
ELEMENTS OF OPTOELECTRONICS 2	W04 027	1	15	Application examples of optoelectronics in medicine, industry, telecommunication and military technology.
MICROPROCESSOR TECHNIQUES 1	W04 028	2	30	Binary arithmetic. Basic topics of the microprocessor engineering. Microprocessor system structures and main components: processors, memories, basic peripheral devices, standard buses, additional circuits. Interrupt systems. Methods of input/output device service. Example of CISC microprocessor. Input/output binary and analogue devices.
BASES AND ALGORITHMS OF SIGNAL PROCESSING 1	W04 029	3	45	Classification of signals, mathematical models of signals. Continuous and discrete representations of signals. Spectrum and correlation analysis of signals. Theory of sampling. Analogy modulations and demodulations (DSB, DSB-SC, SSB, SSB-SC, VSB, FM, PM). Pulse modulations (PAM, PDM, PPM, PCM). Coding of information. Interference. Comparison of effectiveness systems of modulation. Time and frequency multiplexing (TDM, FDM). Adaptive filters. Complex systems of modulation (MASK, MPSK, MFSK, MPCM).
SEMICONDUCTOR DEVICES 2	W04 030	2	30	LABORATORY investigations of characteristics, parameters, properties and chosen applications of semiconductor devices such as diodes, transistors and optoelectronic elements, operational amplifiers and digital gates.
POWER ELECTRONICS 1	W04 031	2	30	Line-frequency diode rectifiers with and LC filters. The one phase – controlled rectifier with reactive load. DC to DC switch - mode converters (control characteristic, conduction and switching power dissipation, efficiency). The two – quadrant converter with active load. Control of the converter with the feedback loops. The small signals dynamic model of the converter. Transformers and Inductors design. Flyback and Forward converters, the bridge converter with transformer isolation. The one phase voltage converter with reactive load. Control of bridge configuration voltage converter, PWM methods of control.
ELECTRONIC CIRCUITS 1	W04 032	4	45	Linear and non-linear application of operational amplifiers. Measurement amplifiers. Transconductance and transimpedance amplifiers. Comparators. Sinusoidal oscillators. Impulse regeneration systems. Voltage controlled oscillators. Phase locked loop. Active filters.

INTERFERENCE PROTECTION 2	W04 033	2	30	The course concerns: a.c. power mains voltage variations, mechanisms of generating of surge voltages and surge currents, behaviour and properties of surge generators in different load conditions, properties of surge protective devices, susceptibility of receiving TV sets to electromagnetic fields, electrostatic discharge, investigations of shielding effectiveness of various screen types, travelling wave phenomena in long cable lines.
NON-ELECTRICAL QUANTITIES MEASUREMENTS 2	W04 034	2	30	Temperature measurements: temperature sensors tests. Mechanical quantities measurements: inductive transducers tests, mechanical vibrations analysis, extensometric measurements using Spider 8 system. Application of absorption photometry in substance concentration measurements, methods of concentration and activity measurements of atoms and ions in water solutions. Measurement of particle properties in suspensions using conductometric method.
AUTOMATIC CONTROL ENGINEERING 1	W04 035	2	30	The subject covers methods of describing and analysing dynamic properties of controlled plants, and linear and non-linear, continues and discrete automatic control systems.
Fifth Semester				
TELECOMMUNICATIONS SYSTEMS AND NETWORKS 2	W05 036	1	30	Measurements of cable system parameters. Configuring and maintaining a PBX device. Networking tools in Windows and Linux operating systems. Network configuration of Windows and Linux systems. Using the network analyzer. Building, configuring and troubleshooting LAN Ethernet network. Using switch in an Ethernet network. Building and testing a data link with modem devices. Testing TCP/IP family protocols (IP, UDP, TCP, ARP, ICMP). Configuring and testing DNS service.
ELECTRONICS MEASUREMENTS 1	W05 037	2	30	The chosen components of the electronic measurement instruments: input high impedance dividers and other input circuits with frequency compensation, programmable gain preamplifier circuits. The review of the constructions of A/D and D/A converters which are of great importance for the measurement instruments. MAD and true-RMS-converters. The measurements of nonsinusoidal voltages issues. The comparison between various implementations of the RMS equation, e.g. thermal, implicit and explicit computation and the more commonly used "average" rectified value detector. The algorithms of digital RMS-measurements. R,L,C,Q and Z ,φ-meters. The measurements of the nonlinearity distortion. Digital oscilloscopes and digitizers: structures, sampling modes, display's update rate, gradient-displaying technology. The algorithms of digital measurements of frequency and time. Analog and digital waveform generators. The detailed description of the structures and operation of DDS's, phase increment registers. PLL frequency synthesizer family, their constructions and operations. The interaction of measurement electronic instruments with PC. Virtual instruments.
MICROPROCESSOR TECHNIQUES 2	W05 038	2	30	Practical exercises in programming of 8-bit microprocessor systems: arithmetic, subroutines, interrupt service, input/output device service
DIGITAL SIGNAL PROCESSING 2	W05 039	2	30	Theory and application of digital signal processing. Sampling of continuous-time signals: the sampling theorem, antialiasing. Description of discrete time signals and systems, impulse response, Z - transform, transfer function, frequency response, state space representation. Properties and application of the Discrete Fourier Transform; Fast Fourier Transform algorithms. Overview of digital filter synthesis and application: infinite impulse response and finite impulse response filters, time and frequency domain parameters, windowing, impulse response, convolution, speed and precision comparison.
RADIOELECTRONIC DEVICES 1	W05 040	3	45	Basic types and structures of radioelectronic devices. General characteristics, parameters and diagrams of amplifiers, transistor and varactor frequency multipliers. LC and XO oscillators. AM, FM, PM and SSB modulation. AM, FM and PM modulators and demodulators. The computations and designing of radioelectronic devices. Generators and power amplifiers, transistor and varactor frequency multipliers.
POWER ELECTRONICS 2	W05 041	2	30	The pulse power supplies. Buck, Boost, Buck-boost converter, the flyback converter. Pulse with control and modulation techniques for the voltage converter. The Indirect DC/DC converter with transformer isolation. The closed control loops of the pulse supplies, The diode rectifier.

ELECTRONIC CIRCUITS 2	W05 042	2	30	Laboratory investigation of some electronic circuits. Differential amplifiers. Linear and non-linear application of operational amplifiers. Voltage regulators. Voltage controlled oscillators. Phase locked loop. AD and DA converters. Timers. Integrated circuits.
PRIMARY COURSE OF TELECOMMUNICATION	W05 043	4	45	Structure of modern telecommunication network. Transmission theory. Properties of communication channels, matching, attenuation and insertion loss; amplitude and phase distortion; nonlinear distortion; filter characteristics. Pulse amplitude modulation; time division multiplexing; sampling theorem; pulse code modulation; pulse shaping and inter symbol interference in digital transmission; delta modulation; differential PCM. Introduction to line codes. Switching Systems. Public Switched Telephone Network (PSTN). Integrated Services Digital Network (ISDN). Architecture of cell systems – NMT, GSM, IS-95 and UMTS. Geostationary satellite systems and LEO
AUTOMATIC CONTROL ENGINEERING 2	W05 044	1	15	During the laboratory sessions, among others, typical automatic systems with PID controllers, digital controllers and relay control systems are studied
Sixth Semester				
EXPLOITATION OF ELECTRONIC AND TELECOMMUNICATION SYSTEMS	W06 045	3	45	Grounding and bonding in telecommunication buildings. Protection against ESD. Cabinets, cubicles and chambers. Coupling from and within cables. Installing cable systems. Concept and models of information technology security. Managing and planning information technology security. Diagnostic and maintenance technique.
ELECTRONIC MEASUREMENTS 2	W06 046	2	30	The exercises improve skills in the measuring of various magnitudes, especially in advanced measurements of electrical signals and parameters of electrical circuits. The students recognize up-to-date gauges, actual measurement algorithms and the capacity for further processing of measuring data. The laboratory offers models for visualization of operations and functions of the most important elements of measurement instruments. The programme includes the most important groups of the measurement instruments: voltmeters, DMM, scopometers, R,L,C,Q- and $ Z , \varphi$ -meters, oscilloscopes, analog and digital waveform generators, especially DDS and PLL synthesizers and more advanced instruments.
DIGITAL SIGNAL PROCESSING 3	W06 047	2	30	Application of digital signal processing methods. Sampling of continuous-time signals, antialiasing. The Discrete Fourier Transform and Fast Fourier Transform implementation and analysis. Synthesis and application of the infinite impulse response and finite impulse response filters; time and frequency response, filtering, implementation issues.
RADIOELECTRONIC DEVICES 2	W06 048	3	30	Experimental study of AM and FM modulators and demodulators, LC and XO oscillators, multi-channel power amplifiers with phase commutators, pulse power supply devices, IF mixers.
Seventh Semester				
MATHEMATICS 3	W07 060	3	45	Elements of probability. Basic issues of statistics. The estimation of parameters. The testing of hypotheses. Linear regression. Elements of stochastic processes. Integral calculus of several real variables. Integrals of complex functions. Elements of partial differential equations (classification, equations of the first and second order, boundary and initial problems, methods of solving). Metric spaces, Banach spaces. Elements of calculus of variation. Difference equations. Dynamical systems.
PHYSICS 3	W07 061	2	30	Radiation of thermal and laser sources – similarities and differences. Laser generator – construction, working conditions, some solutions of laser technology elements. Three- and four-level model of a laser medium. Population inversion, gain. Methods of population inversion creation. He-Ne laser – energy level diagram, construction, parameters, selected applications. CO ₂ laser - energy level diagram, construction, parameters, selected applications. Fiber lasers and amplifiers. Methods of pulse generation. Semiconductor lasers – construction, parameters. Methods of frequency stabilization of generated radiation – frequency standards.

METHODOLOGY OF DESIGN AND REALIZATION TECHNIQUES	W07 062	4	60	The structures and stages of electronic equipment design. Basics of computer design methods and realization techniques. Mathematical and circuit models of electronic devices in time and frequency domain. Topological foundations of creating device models. The modelling and design of electronic and telecommunications equipment.
ELECTROMAGNETIC FIELD THEORY	W07 063	3	45	Vector analysis – co-ordinate systems, vector operations. Maxwell's equations, electromagnetic properties of physical media. Boundary conditions of the electromagnetic field. Energy and power of the electromagnetic field, Poynting's theorem. Transverse electromagnetic wave, perpendicular and slant incidence, propagation through a multilayer medium. Electrodynamic potentials, quasistationary conditions. Transmission lines, field and circuit parameters. Waveguides, E and H field modes, fundamental mode, field distribution within waveguides. Resonators, field modes, field distribution within resonators. Electromagnetic field radiation and antennas. Electromagnetic waves propagation in the atmosphere.
OPTOELECTRONIC DEVICES AND SYSTEMS 1	W07 064	2	30	Applications of optoelectronic systems and devices. The principles of optical fibers. Optoelectronic devices (fiber amplifiers, couplers, integrated optics elements, sensors). Electrooptic, acoustooptic and magneto-optic phenomena. Optical fibre networks (analog, digital, coherence transmission, measurements).
ELECTRONICS PULSE SYSTEMS 1	W07 065	3	30	Power factor correction rectifiers (DCM and CCM conduction modes). Closed loop control of DC/AC a voltage converter. Uninterruptible power systems. Series and parallel – loaded resonant – switch converters. Class – E converters. The converter filters design. Transistor converters applications examples.
PROCESS DYNAMICS 1	W07 066	1	15	Object as dynamic element, dynamics of linear and non-linear objects. Kinematics of substance transport: flow and volume regulation, transport and transport delays. Fluid motion: level regulation, regulation of compressible and incompressible liquid, pressure regulation. Thermal processes dynamics: physical approach, thermal processes regulation. Mass interpenetration process dynamics. Chemical processes dynamics: reaction kinetics, chemical reaction systems regulation, dynamic elements of reactors, composition regulation.
Eighth Semester				
PHYSICAL EDUCATION 3	W08 067	0	30	
TECHNIQUE OF EXPERIMENT 1	W08 068	2	30	Measurement and estimation of its results. Uncertainty, error and precision. The processing and reproduction of measuring signals. Measurement as indispensable part of experiment. Planning and organization of an experiment.
DIGITAL SIGNAL PROCESSORS 1	W08 069	3	30	Overview of a way from digital signal processing project to the full DSP processor implementation. Digital signal processors: fixed and floating point. DSP architecture: central processing unit, memory, interrupts, DMA, memory cache, serial ports, timers, input/output peripheral. DSP instruction set. Hardware design techniques, JTAG, power-down modes. Software development tools: assembler, compiler, linker, software optimization. DSP implementation of selected signal processing algorithms. Programming tips.
DIGITAL MEASUREMENT SYSTEMS 1	W08 070	3	30	Organization of digital measurement systems and measurement signal path. Signal conditioning – typical solutions and modules. PC-based signal acquisition – multifunction input-output boards: architecture and programming. Serial interfaces: V.24 and V.28 standards, RS 232C, RS 423, RS422, RS485. Parallel measurement interface IEC-625 (IEEE 488) – architecture and programming. SCPI standard: virtual device model, command hierarchy, programming of measurement devices. Virtual measurement devices in graphical environment – LabView, WorkBench, DADiSP. Distributed measurement systems. Wireless measurement systems.
OPTOELECTRONIC DEVICES AND SYSTEMS 2	W08 071	2	30	The measurements of optical fibre parameters (numerical aperture, attenuation, refractive index profile). Fiberscope - structures, resolution. Couplers measurements.

ELECTRONICS PULSE SYSTEMS 2	W08 072	1	15	The ZVS quasi-resonant converters, characteristics and waveforms.. The series resonant converters with a series load, DC/AC and DC/DC configurations with and without transformer isolation. The series resonant converters with a parallelly load, DC/AC and DC/DC configurations, with and without a transformer isolation. The one phase power factor correction system. The ZCS quasi-resonant converters. The voltage converter controlled as a current supply.
PROCESS DYNAMICS 2	W08 073	1	15	Dynamics of electric systems: basic dynamic objects in electronics. Dynamics of thermal processes: thermostat as an object of temperature regulation, dynamics of thermal transducers. Dynamics of electric drives: electric motor with gear used for speed regulation in peristaltic pump. Dynamics of mixing processes: diluting process of electrolytic solution controlled by conductometric transducer. Light process dynamics: wolfram bulb in absorption photometer as an object in luminous flux regulation system.
Ninth Semester				
ELECTROMAGNETIC COMPATIBILITY	W09 074	3	45	Introduction to EMC. Standards and units. Signal and their spectra. Sources of continuous and transient electromagnetic interferences. Control of radiated and conductive interferences. Immunity requirements for devices and systems. Capacitive and inductive crosstalk, voltage dips and interruption. Electromagnetic shielding effectiveness. Protective elements and systems. Practical EMC Design of equipments and systems.
TECHNIQUE OF EXPERIMENT 2	W09 075	1	15	Estimating of an accuracy. Uncertainty in computer measuring systems. Virtual systems in LAB View environment. Measurements and data handling by internet.
DIGITAL SIGNAL PROCESSORS 2	W09 076	3	45	Programming of digital signal processors. Fixed and floating point digital signal processors. Software development using assembler and C++, software optimization. Controlling of the peripheral controllers: memory, interrupt, DMA, cache, serial port, timer, input/output. Controlling of the A/D and D/A converters; signal acquisition, real time data processing. DSPs implementation of selected algorithms: FIR, IIR and adaptive filters, FFT, signal compression.
DIGITAL MEASUREMENT SYSTEMS 2	W09 077	1	15	Programming multifunction input-output boards in a PC-based signal acquisition system. Communication between computers and measurement devices via serial interfaces: RS 232C and RS485. Data acquisition with the use of parallel measurement interface (IEC-625). Building and programming of measurement systems in 'LabView' graphical environment.
PROSEMINARY	W09 078	2	30	Selected problems of electronic, telecommunication and data communications. Basic tendencies of the electronic equipment development. Computer-aided design and testing of electronic equipment. Discussion about method of writing of master's thesis, formal requirements. Student's reports about the realization of their thesis, partial tasks and various problems connected with master's thesis.
FOREIGN LANGUAGE	W0x 1xx	2	30	English, German, Russian, French
PHEM	W0x 1xx	2	30	A course selected from a group of courses in the humanities, economy and management.

Core subjects for specialization Electronic Equipment

Fourth Semester				
TRANSMISSION LINES	W14 200	3	30	Basic properties of TEM wave. Quasi-stationarity condition. Concept of distributed-parameters circuit. Equivalent circuit of short segment of TEM line. Differential equations of transmission line and their solution for sinusoidal excitation. Characteristic impedance, propagation coefficient. Reflection of waves, phase velocity, group velocity, dispersion effect. Reflection coefficient, standing wave ratio, impedance matching. Input impedance. Distortionless line, lossless line. Transmission line as an impedance transformer. Voltage and current envelopes along TEM line. TEM line in transient state for step excitation.

TECHNOLOGICAL LABORATORY 2	W14 201	1	15	Computer aided design of simple electronic circuit scheme. Printed circuit board project on the basis of scheme. PCB prototype fabrication (laminare preparation, UV explaining and drilling). Soldering and final device testing.
Fifth Semester				
HIGH FREQUENCY TECHNIQUES 1	W15 202	3	45	Applications of microwaves. Basis equations of electrodynamics, boundary conditions. Transmission lines, waveguides. TEM, TE and TM modes. Definitions of current, voltage, characteristic impedance. Smith chart. Impedance matching. Multiport circuits, scattering matrix. Passive microwave elements: reactance irises, matched loads, stub tuners, attenuators, phase shifters, power dividers, hybrid junctions, directional couplers. Resonators and filters. Ferrite devices. Semiconductor devices: IMPATT diode, Gunn element, MESFET transistor. Measurements of wave length, frequency, power, scattering parameters. Network analyzers.
Sixth Semester				
HIGH FREQUENCY TECHNIQUES 2	W16 203	2	30	Laboratory experiments with waveguides and quasi-TEM devices. Measurements of wave length and frequency. Measurements of SWR, reflection coefficient, and impedance. Electromagnetic waves in transmission line (including transients). Measurements of power and attenuation. Measurements of scattering parameters of microstrip multiports. Microstrip filters and resonators.
Seventh Semester				
APPLICATION OF MICROCONTROLLERS 1	W17 204	2	30	Principles of theory of the microcontrollers. Practical approach to the control and signal processing for the industry, medical, environmental measurements applications, home automation, utility metering etc. Newest trends in the devices supports higher-end applications. Development tools for the microcontrollers. Low power version of the microcontrollers for the wireless communications.
ELECTRONIC EQUIPMENT DESIGN AND TECHNOLOGY	W17 205	2	30	The organization of design and technology office in a business enterprise. The production and assembly of PCBs. Production of microstructures, transistors, diodes and IC. Sensors for electronic equipment. Materials for and construction of the EM shields. The thermal problems in micro-miniatures and electronics equipment. Recycling in electronics.
IMAGE PROCESSING	W17 206	4	60	Basic information about digital image, mathematical model of image, image sampling and quantization, model of noise. Methods of image enhancement by point processing, gradient techniques. Morphological operations. Methods of compression and decompression of digital images. Image recognition methods, patterns and pattern classes. Usefulness of systems of image analysis and recognition.
APPLICATION OF THE ELECTRONIC CIRCUITS 1	W17 207	3	45	Application of the operation amplifiers for the signal filtering, conditioning and mathematical operation. Function generators, peak-to-peak detectors, sample and hold circuits, integrators. Analog and digital time circuits. Switches, multiplexers and demultiplexers in the signal transmission. Rail-to rail and instrumentaion amplifiers in the measurement techniques. Application of the specialized circuits for the signal conditioning. Analog-digital and digital-analog converters. RMS detectors. Application of the optoelectronic circuits. Electronic circuits for the motors control (drivers for the DC, AC motors, stepper motors, servo controllers etc.). Power supply for the electronic equipment. Power and thermal management. Electronic circuit for the temperature, pressure, force, displacement, acceleration, tilt and rotation measurement.
Eighth Semester				
MICROCONTROLLER APPLICATIONS 2	W18 208	2	30	Miscellaneous microcontrollers programming: timer/counters, interrupt system, external and internal ADC and DAC converters servicing, serial interfaces (SPI, I2C, UART), keyboard and display servicing, devices sleep modes.
SENSOR DEVICES 1	W18 209	3	30	The classification of sensors. Basic concepts in sensor technology. Sensors of physical quantities. The structures and basic properties of biosensors, optoelectronic sensors, smart sensors, matrix sensors and chemical sensors.

APPLICATION OF THE ELECTRONIC CIRCUITS 2	W18 210	1	15	Designing several electronic circuits and simple systems where the analog and digital circuits play main role (for example: voltage, temperature and frequency measurement). Range of the projects in the laboratory depends on the student possibilities and their practical activity. Results of their work are proportional to the knowledge from the earlier experience in the circuits application.
Ninth Semester				
SENSOR DEVICES 2	W19 211	1	15	Measurements of basic parameters and characteristics of force, pressure, acceleration and temperature sensors. The use of sensors in industry.

Specialization: Electronic Equipment; Branch of qualify: Wireless Telecommunications

Fifth Semester				
PROFESSIONAL ELECTRONIC CIRCUITS 1	W15 220	2	30	Power management in the industry systems. Amplifiers circuits: operation, isolation, programmable and instrumental amplifiers in the different applications. Multiplexing signals with analog switches. High accuracy sample and hold circuitry. Analog-to-Digital Converters, Digital-to-Analog Converters in the industry, audio-video, measurement and control equipment. Sensor signal conditioning and transmission. The special electronic (analog and digital) circuits. Elimination and reduction of the electromagnetic disturbances in the electronic circuits.
COMPUTER-AIDED DESIGN OF ELECTRONIC EQUIPMENT 1	W15 221	1	30	Fundamentals and stages of computer-aided design (CAD) of electronic equipment. Computer circuit models of electronic devices and components. Algorithms and computational methods for the time and frequency network analysis. Optimization techniques in electronic devices.
ENGINEERING SOFTWARE	W15 222	2	45	The structure and stages of the electronic devices design for microwave frequencies. Mathematical models of the transmission line, active and passive electronic elements for ultra high frequencies. Algorithms and methods of the design of electronic devices with distributed elements. Review of popular software for microstrip circuits modelling and numerical analysis. Using of different types of matrices and their transformation.
Sixth Semester				
RADIOELECTRONIC DEVICES 3	W16 223	3	60	The computations of parameters and characteristics of radioelectronic devices. Self-excited Colpitts generator. Pierce quartz oscillator. AM and FM modulators and demodulators. Broadband LC filters. Mixers and IF networks. Voltage stabilizers. Testing of the AM and FM receivers. Measurements of transmission lines and terminators.
RADIO AND TELEVISION DEVICES 1	W16 224	3	45	Sound's characteristic. Classification of the radio receivers. Superheterodyne receiver – main blocks. Stereocoders and stereodecoders. FMX stereo system. ARI, RDS, paging. Surround systems. Dolby systems. Sound coding and compression (MUSICAM, MPEG, MP3). Digital radio receivers, GSM and WCDMA terminals. DAT and DCC recorder, CD recorder. Modern radiocommunications systems – future tendentious. Radio-receivers norm and recommendations.
TELECOMMUNICATION DEVICES	W16 225	5	75	The structures and parameters of transmitters and receivers in telecommunications systems. The automatic gain and frequency regulation, frequency, phase techniques, the PLL. Frequency synthesizers. Fundamentals of radiocommunication systems. Multi-access FDMA, TDMA, CDMA. The structures and basic parameters of the GSM system. Calculation and the design of broadband radio channel, design of the generators, broadband amplifiers and filters of the radiocommunication channel.
TELEVISION ENGINEERING	W16 226	2	30	The lecture presents description of the light, human visual system properties, image sensors, video displays and video signal transmission. Solutions and features of modern television displays as well as image sensors are presented. Specifications of most important program colour-television standards are given. Some of problems of High Definition Television systems are discussed. There are also modern systems of TV-sound transmission (e.g. Nicam) presented. The lecture is supplemented by laboratory exercises presenting selected topics from the above list.

PROFESSIONAL ELECTRONIC CIRCUITS 2	W16 227	2	30	Linear and switching regulators. Low-Dropout regulators for battery-operated portable equipment. Charge-Pump, switched-capacitor voltage converter, DC/DC step-up and step-down converters. High voltage amplifiers, comparators, function generators, peak detectors. Parallel and serial voltage output A/D and D/A converters. Analog circuits for the mathematical operation. Sensor signal conditioning and transmission. Electronic circuits in the regulators and remote control.
COMPUTER-AIDED DESIGN OF ELECTRONIC EQUIPMENT 2	W16 228	2	30	Computer modelling, analysis and optimization of circuit with distributed elements. Design of different types of transmission lines: coaxial lines, microstrip lines, strip lines. Design of microwave filters and matching circuits. Using software for computer analysis of electronic equipment for ultra high frequencies.
Eighth Semester				
ANTENNAS AND WAVE PROPAGATION	W18 229	3	45	Classification of antennas. Basis of theory of radiation. Parameters of antennas. Hertz dipole, magnetic dipole. Thin symmetric vibrator, half-wave and short dipole. Influence of earth and surroundings on properties of antennas. Feeding of antennas, impedance matching. Summation of radiated fields. Antenna arrays. Antennas with reflectors. Yagi-Uda antennas. Traveling-wave antennas. Idea of frequency-independent antennas. Log-periodic antennas. Aperture antennas. Horn antennas, lens antennas, antennas with parabolic reflector. Structure of atmosphere, its daily and seasonal changes. Properties of propagation of electromagnetic waves in atmosphere for different frequency ranges.
WIRELESS TRANSMISSION SYSTEMS 1	W18 230	2	30	The structure of multiport transmit-receive complexes in wireless transmission systems. Radio channels for different frequency bands. Wave propagation models. Mathematical foundations of multiport complexes. Broadband transmit complexes, design of base elements; the Rayleigh ratio, maximization of power parameters; multiport broadband matching of complex loads. The SDMA systems, smart antennas and antenna arrays; adaptive antenna arrays. Basics of the different radiocommunication systems (GSM, TETRA, DECT, UMTS, satellite systems).
RADIO AND TELEVISION DEVICES 2	W18 231	4	60	Television systems and standards. TV-receiver block structure. Television signal components. Composite video signal (CVBS). Color TV standards: PAL, SECAM, NTSC. TV tuners. IF block. Vision demodulator and amplifier. AFC and AGC. Sound demodulator (mono and stereo). NICAM stereo system. Synchronization and deflection blocks. Power supply block. High Definition TV. Cable television. Industrial television. Digital TV-receivers. Satellite television. D2-MAC standard. Technical researches of TV color receivers. Norms and recommendation for TV systems.
Ninth Semester				
PROJECT WORK	W19 232	2	30	Computer analysis of different radiocommunication antennas. Scanning direction of radiation of the antenna array. Changing shape of the radiation pattern of the antenna array. Design of multiport drivers networks for the antenna array. Broadband matching of multiport antenna array. Using of frequency and phase commutator in the antenna arrays.
TELECOMMUNICATION CONTROL SYSTEMS	W19 233	4	45	Mathematical analysis of control systems. Structure of the system, transmittance, stability conditions. Noise and impulse disturbance analysis of the system. Discrete and nonlinear control systems. The Kalman's filters. Synchronization in digital telecommunication systems. Phase locked loop, noise characteristics. Symbolic synchronization. Open and feedback control systems. Frame synchronization. Synchronization in telecommunication systems with different coding methods.

ELECTRONIC MEASUREMENT INSTRUMENTS	W19 234	4	45	Fundamentals of waveform digitizing. The review of the fast A/D converters. Analog and digital spectrum analyzers, their construction, block diagrams and its capability to provide the measurement in the domain of frequency, time and modulation. The characteristic, functional properties and control of the instrument displays. The common mode and series mode distortions and methods of rejection. The analog and digital methods of rejection of the noise and distortions in the measuring instruments. The procedures of this rejection in the time domain and the frequency domein. The applications of the microcontrollers and microprocessors in the measuring instruments. Functions of autoranging and autocalibrating, the correction of errors of intelligent measuring converters. Virtual instruments, their configurations, features and the integrated computer environments for its realization.
DIGITAL RADIO LINKS	W19 235	4	45	The classification of radio links, digital transmission systems, microwave systems. Design of radio channels, Fresnel zones, analysis of losses of microwave radio signals. Different digital radio systems, power system balance, ultrawideband systems, structure and main parameters of UMTS. Satellite radio diffusion systems, models of radio channels, structure of satellite receivers, digital TV systems DVB. Project of digital radio link, optimization of the radio routs by different methods, design and calculations of main parameters and characteristics of digital radio link of small and medium capacity.
WIRELESS TRANSMISSION SYSTEMS 2	W19 236	2	30	Investigations of the base elements of radiocommunication systems. Measurements of simple and complex devices used for wireless data transmission. Radio wave propagation, broadband matching of multiport radio systems, electronic beam forming of antenna arrays.
MEDICAL ELECTRONIC APPARATUS	W19 237	3	60	Classification of the medical equipment – range of the applications. Method and the devices for the biological signals registration. Electrocardiography, electrode systems, method of the ECG, EEG and EMG analysis. Invasive and noninvasive method for the blood pressure measurement and registration. Ultrasound methods for the blood flow measurement. Intracranial pressure measurements. Electronic equipment for the diagnosis and therapy in the hospitals and ambulatory conditions. Electronic equipment in the intensive care departments in the hospitals (cardiology, gynecology, neurology and neurosurgery departments). Analitical measurements in the medical diagnostic i therapy. The equipment classification for the medical analytic purposes. Absorption spectrophotometers and photometers. Automation in the clinical biochemistry and hematology. The electrical, mechanical and toxic patient safety.
B.SC. SEMINAR	W90 238	30	30	Basic tendencies of the wireless electronic equipment development. Signals and modern types of modulations used in telecommunication. The development of analog, digital and microwave IC. Methods of the computer design and testing of the electronic equipment. Discussion about students' B.Sc. thesis.
M.SC SEMINAR	W91 239	30	30	Basic tendencies of the electronic and telecommunication equipment development. Modern signals and types of modulations and their rule in radio- and telecommunication. Tendencies in the design and production of analog, digital and microwave circuits. Computer-aided design and testing of the electronic equipment. Examples of software for the design and analysis. Discussion about students' master's thesis.

Specialization: Electronic Equipment; Branch of quality: Medical Electronic Equipment

Fifth Semester				
BIOPHYSICS 1	W15 250	1	30	Structural elements of the matter. Thermodynamics of biotic processes: thermodynamics of biological processes, energy transformations in metabolism processes. Biophysics of cells and tissues. Biophysics of organs. Influence of physical conditions on live organism: influence of electric and magnetic fields, non-ionizing and ionizing radiation.

PRIMARY COURSE OF MEDICINE 1	W15 251	3	60	Background of human anatomy and physiology, organs and systems, its cells and tissues: Bones and joints, muscles, mobile system function. Gastro-intestinal tract and its function, respiratory system, uro-genital system, cardio-vascular system and function, lymphatic system, cerebro-nerve system and function, endocrine system: hormones and their actions, sensory organs, blood, lymph and other systemic fluids of human body. Theoretical and practical aspects of Rheumatology, Metabolic bone diseases, Degenerative joints disorders, Pain clinic, Pulmonology and Respiratory tract functions tests including bronchoscopes, Hematology and Immunology, Gastroenterology and endoscopies: gastroscopy and rectoscopy.
Sixth Semester				
SIGNAL PROCESSING AND MODELING OF BIOLOGICAL SYSTEMS	W16 252	3	45	Course presents classification, methods of acquisition and processing techniques for various biomedical signals based on mathematical modeling. Scope of lecture covers description of selected active subsystems in the human body. Formalism for mathematical approach to the typical biomedical signals is introduced. Course discusses among other things such processes like: filtration, detection, time-frequency representation, high order spectra, compression. Special algorithms for biomedical signals are explained. Signal is viewed like source of information about biological system condition. It is also useful for biomedical system models creation and identification. Compartmental models are showed as good choice for biological and environmental processes. Exercises using computer simulating software aims in illustration of work biological subsystems and model in medical practice.
ELECTRONIC IN MEDICAL ENGINEERING	W16 253	3	60	Biological amplifiers. Isolation amplifier features. High accuracy sample and hold circuitry. High accuracy Analog-to-Digital Converters, Digital-to-Analog Converters in the medical equipment. Sensor signal conditioning and transmission from medical sensors. Digital processing in the medical equipment. Power management in the stationary and battery-operated portable medical equipment. Electromagnetic disturbances in the medical electronic.
MEDICAL ELECTRONIC APPARATUS	W16 254	5	60	Classification of the medical equipment – range of the applications. Method and the devices for the biological signals registration. Electrocardiography, electrode systems, method of the ECG, EEG and EMG analysis. Invasive and noninvasive method for the blood pressure measurement and registration. Ultrasound methods for the blood flow measurement. Intracranial pressure measurements. Electronic equipment for the diagnosis and therapy in the hospitals and ambulatory conditions. Electronic equipment in the intensive care departments in the hospitals (cardiology, gynecology, neurology and neurosurgery departments).
MEASUREMENTS IN MEDICINE	W16 255	2	45	Human as a source of biological signals. Overview of medical measurement methods. Mechanical quantities measurement methods. Measurements of organism electrical quantities. Measurement of physicochemical quantities. Statistical methods in medical examinations. Application of absorption photometry in clinical biochemistry. Usage of reflectance transducers in quick diagnostic tests. Measurement of sodium and potassium ion concentration using emission flame photometry. Measurements of basic hematological parameters. Application of „Statistica” program for measurement results analysis.
BIOPHYSICS 2	W16 256	1	15	Electric effects in muscle fibre. Relation between EKG curve and electric effects in heart, electrocardiograph drains. Biophysics of organs of hearing and speaking. Audiometry. Ionizing radiation and its use in diagnostics.

PRIMARY COURSE OF MEDICINE 2	W16 257	3	60	<p>Understanding and diagnosis of most often seen diseases of:</p> <p>Respiratory tract: Pneumonia, tuberculosis, bronchitis, and bronchial asthma; Digestive tract: Ulcer disease, cancer of stomach, cholelithiasis, and pancreatitis; Cardio-vascular system: Pectoral angina, ischaemic heart disease, arrhythmias, and cardiac arrest; Uro-genital system: Urolithiasis, uremia, nephropathy, pregnancy and delivery.</p> <p>Practical classes at the Emergency Department, Admittance Room, Electrocardiography, Ultrasonography, Hospital Pharmacy, Intensive Care Unit and Cardiology Department, Surgery, Orthopedic and Urology Departments, Laryngology, Ophthalmology and Outpatients Departments at the General Hospital of Bialystok. Forensic Medicine Department, Pediatric Clinic, Department of Analytical Biochemistry and Clinical Pathology at the Medical University of Bialystok.</p>
Eighth Semester				
IMAGE PROCESSING IN MEDICINE 1	W18 258	3	30	X-ray radiation and its biological effects. X-ray diagnostic apparatus – structure and operation. Methods and equipment used for image recording, digital image processing. Computer tomography. Ultrasound diagnostics. Nuclear magnetic resonance (NMR).
ULTRASONIC METHODS IN MEDICINE 1	W18 259	2	45	Ultrasonic methods used in diagnostics and therapy of muscular-skeleton tissue. Ultrasonic visualization of blood flow: Doppler effect, principle of blood flow in vessels and heart imaging. Ultrasonic Doppler method used for fetal movements activity evaluation. Ultrasonic methods in therapy: physical basis of stone disintegration process, structure of lithotrypters.
ANALYTICAL AND LABORATORY EQUIPMENT 1	W18 260	2	30	Sense of analytical measurements for process of diagnosis and treatment. Absorption spectrophotometers, density meters. Flame and nuclear absorption photometers. Using light diffusion in laboratory diagnostics. Conductometry and pH-metry. Systems used for measurement of acid-base equilibrium in human organism. Concentration measurement equipment using ionoselective electrodes.
INFORMATICS IN MEDICINE	W18 261	3	60	Review of applications of informatics in medicine. Hospital informatics system: functions in hospital information system. Informatics system: classification, characteristic and structure. Cost and benefits of putting computerized information system. Specification, analysis and range selection of informatics system. Specialized database about patients: requirements, structure, protection. Programming to selected module of database. Computing to aid diagnosis and therapy. Experts systems: formation, structure and selection rules of inference.
Ninth Semester				
LASERS IN MEDICINE	W19 262	3	30	Introduction to tissue optics. Characterization methods of biological tissues. Selected processes of laser radiation interaction with tissues. Shaping methods of laser radiation distribution in tissues. Measuring methods and systems utilizing laser radiation in diagnostics. Selected methods and equipment used in LLLT. Laser therapeutic systems. Development direction of laser medical equipment.
BIOCYBERNETICS	W19 263	3	45	<p>Methods and techniques of biological systems modeling. The human organism as a hierarchical, adaptive control system – control and regulation processes in living organisms. Basic information systems and processes in a human body, structure and functions of nervous, hormonal and immune systems. Human brain – information processing, learning, control and adaptation. Human nerve cell and its mathematical and cybernetic models.</p> <p>Methods and algorithms of computational intelligence: artificial neural networks (model of an artificial neuron, typical architectures, training algorithms), fuzzy sets and fuzzy systems (fuzzy approximation, classification, modeling and control), neuro-fuzzy systems, genetic algorithms and genetic programming, rough sets. Typical applications of artificial intelligence: pattern recognition, classification, data compression, feature extraction, system modeling and identification, control, diagnostics.</p> <p>Bio-measurement systems – acquisition and processing of biomedical signals. Biological and technical perception systems, cybernetic models of sense organs. Methods and systems of image and speech recognition.</p>

BIOMATERIALS	W19 264	3	45	Fundamentals of materials technology with the emphasis on medical materials. Biomaterials used in bone surgery and stomatology. Materials used for tissue integration. Dressing materials. Surgical instruments. Testing methods for biomaterials.
IMAGE PROCESSING IN MEDICINE 2	W19 265	2	30	Influence of X-ray radiation and exposition conditions on pictures quality. Principle of operation of osteodensity meter. Diagnostic examinations using computer tomography. Examinations of ultrasonic heads and diagnostic possibilities evaluation. Diagnostic examinations of thyroid gland and abdominal cavity using ultrasonic apparatus.
BIOMECHANICS	W19 266	2	30	Mechanics of the human body; structural models of the human skeleton and limbs. Mechanics of tissues. The analysis of static and dynamic muscle and joint loads. Biomechanics of limbs and spinal column.
ULTRASONIC METHODS IN MEDICINE 2	W19 267	1	15	Attenuation and absorption of ultrasonic waves, multi-element heads, measurements in ultrasonography. Ultrasonic visualization of blood flow: Doppler effect, principle of blood flow in vessels and heart imaging. Ultrasonic methods used for carotid artery diagnosis: ultrasonic equipment used for artery vascular walls flexibility.
ANALYTICAL AND LABORATORY EQUIPMENT 2	W19 268	1	15	Analytical equipment examination with agreement of manufacturer technical conditions. Design and examinations of absorption photometers. Equipment used for electrochemical quantities measurements: base-acid and water-electrolyte equilibrium analyzers. Principles of construction, design and examination of hematological systems.
PILOT PROJECT	W19 269	4	30	Description of research and development cycle: study and evaluation of brief foredesign, evaluation of preliminary design, making the model, examinations of the model, evaluation of technical project, making the prototype. Assignment of subject for project subgroups (2–4 people) and discussion. Assessment of current technology state using available professional literature. Realization of projects. Discussion and assessment of projects.
B.SC. SEMINAR	W92 270	30	30	Methodology of thesis writing, usage of professional literature; conveying extended knowledge connected with student specialization, basing on literature study connected with thesis filed. Consideration of formal side of preparing and defense of the thesis. Presentation of papers (trial defenses), discussion and correction of essential and methodical mistakes.
M.SC SEMINAR	W93 271	30	30	Methodology of thesis writing, usage of professional literature; conveying extended knowledge connected with student specialization, basing on literature study connected with thesis filed. Consideration of formal side of preparing and defense of the thesis. Presentation of papers (trial defenses), discussion and correction of essential and methodical mistakes.

Specialization: Teleinformatics

Fourth Semester				
OBJECT-ORIENTED PROGRAMMING APPLICATIONS	W24 300	3	60	Structural programming. Introduction to programming in language C. Object-oriented programming concepts. Introduction to programming in language C++. Object, classes, messages, inheritance, interface, Standard libraries. Streams. Templates of classes and functions, namespaces, exceptions. Standard Template Library (STL). Visual C++. Microsoft Foundation Class MFC.
COMPUTER ORGANIZATION AND ARCHITECTURE	W24 301	2	30	Review of computer systems and technologies. Architecture of computer systems. Properties of RISC, CISC architectures and Harvard, von Neuman architectures. Data representation and arithmetic. Role and architecture of computer system components; microprocessor, memory, memory cache, system bus, interrupts, DMA, input/output, serial and parallel interfaces. Execution speed enhancement; parallel processing, pipelining, caching, branch prediction, RISC kernel. Fundamental concepts of the operating systems. Problems of CPU scheduling, memory allocation, paging, processes and threads, storage management, distributed processes and storage mechanisms, security issues.

Fifth Semester				
INTERNET TECHNOLOGIES 1	W25 302	3	45	Evolution of computer and networking services in the last decades. The history of Internet network. WWW as an universal method of access to information and services. Cooperating of WWW servers and browsers. Hyper Text Markup Language (HTML). New components of the HTML and XHTML languages. Creating client-side scripts using JavaScript language. Creating dynamic WWW pages using ASP and ASP.NET technologies. Cooperating ASP scripts with SQL databases. Basics of the XML language. Transforming XML documents using XSLT language. Selected Internet services application-level protocols: SMTP, POP3, FTP, HTTP, NTP, SIP.
PROFESSIONAL ELECTRONIC CIRCUITS 1	W25 303	3	30	Power management in the industry systems. Amplifiers circuits: operation, isolation, programmable and instrumental amplifiers in the different applications. Multiplexing signals with analog switches. High accuracy sample and hold circuitry. Analog-to-Digital Converters, Digital-to-Analog Converters in the industry, audio-video, measurement and control equipment. Sensor signal conditioning and transmission. The special electronic (analog and digital) circuits. Elimination and reduction of the electromagnetic disturbances in the electronic circuits.
DIGITAL SWITCHING SYSTEMS 1	W25 304	2	30	Public Switched Telephone Network (PSTN). Numbering and charging system. Signaling systems. Architecture of a digital switching network. Architecture of digital switching elements. Structure of modules of the S12 Digital Exchange. Structure of software of the S12 Digital Exchange. Local, incoming, outgoing and transit call. The behaviour of telephone traffic.
Sixth Semester				
CORPORATE NETWORKS	W26 305	2	30	Students prepare projects of the network structure for assumed enterprises (usually with a few departments). In typical case the prepared project includes telephone network, computer network, power supply network and some specific components like alarm signaling network or internal television system (CCTV). The finished project should include analysis of demands, suggestion of solutions, diagrams of network structure and the cost estimate. The project can also include other parts, specific for particular application (e.g. analysis of legal aspects of using radio devices). The prepared projects are presented and discussed during the classes.
TELECOMMUNICATIONS SYSTEMS AND NETWORKS 3	W26 306	2	30	Technical examination of Voice over IP transmission system with H.323 or SIP protocol. Configuring routers and LAN switches. Configuring static routing. Configuring and troubleshooting dynamic routing with selected routing protocols (e.g. RIP or IGRP). Configuring virtual local networks (VLAN). Configuring QoS functions on routers and switches. Managing network devices with SNMP protocol. Investigating of structure of MIB database in selected network device like workstation or switch. Configuring selected network management platform.
COMPUTER NETWORK MANAGEMENT	W26 307	1	15	Ideas of computer network management systems. Standards and protocols for network management: SNMP, CMIP, MIB. Structure and content of MIB database. Examples of implementations of SNMP and MIB in routers, switches, servers, UPSs and other devices used in computer networks. Remote monitoring of network devices using RMON protocol. Selected platforms and applications for network management: HP OpenView, Cisco Works, Microsoft MOM. Quality of Service (QoS) management for network systems. Selected queuing algorithms used in QoS systems. Basic QoS architectures: IntServ and DiffServ.
DIGITAL SIGNAL TRANSMISSIONS	W26 308	4	60	The fundamentals of the statistical signal processing. Noises and interferences in transmission channels. Basic principles of the signal detection and parameters estimation. Methods of signal modulation: BPSK, QPSK, AM/PSK, MSK, OFDM. The multiple access methods: FDMA, TDMA, CDMA. Fundamentals of the code theory. The block and convolution codes. Decoding algorithms.

MULTIMEDIA SYSTEMS	W26 309	3	45	Representation of different types of multimedia information (text, voice, image). Mathematical preliminaries and applications of lossless compression (Huffman coding, Golomb codes, arithmetic coding, dictionary techniques). Mathematical preliminaries for lossy compression. Scalar quantization, vector quantization, differential encoding. Introduction to transform coding and subband coding. Speech coding, audio coding, image compression. Analysis-synthesis schemes. Some remarks on wavelet-based compression, video compression. Algorithms for videoconferences, videophones. Video standards: MPEG-1, MPEG-2, MPEG-4, MPEG-7.
INTERNET TECHNOLOGIES 2	W26 310	2	45	Creating static WWW pages using the HTML language. Creating WWW pages using Cascade Style Sheet (CSS). Creating WWW pages with forms. Creating client-side scripts using JavaScript language. Creating dynamic WWW pages using Active Server Pages (ASP) and ASP.NET technologies. Developing ASP scripts with access to SQL database. Creating XML documents. Processing XML documents using XSLT language. Displaying XML documents on WWW pages.
PROFESSIONAL ELECTRONIC CIRCUITS 2	W26 311	2	30	Linear and switching regulators. Low-Dropout regulators for battery-operated portable equipment. Charge-Pump, switched-capacitor voltage converter, DC/DC step-up and step-down converters. High voltage amplifiers, comparators, function generators, peak detectors. Parallel and serial voltage output A/D and D/A converters. Analog circuits for the mathematical operation. Sensor signal conditioning and transmission. Electronic circuits in the regulators and remote control.
DIGITAL SWITCHING SYSTEMS 2	W26 312	2	45	Architecture of the S12 digital exchange. Architecture of a digital switching network. Properties of analog subscriber line. Charging System. Numbering System. A private automatic branch exchange (PABX) Data base system of the S12 digital exchange. Diagnostic tests. Architecture of modules of the S12 Digital Exchange.
Seventh Semester				
APPLICATION OF THE MICROCONTROLLERS 1	W27 313	2	30	Principles of theory of the microcontrollers. Practical approach to the control and signal processing for the industry, medical, environmental measurements applications, home automation, utility metering etc. Newest trends in the devices supports higher-end applications. Development tools for the microcontrollers. Low power version of the microcontrollers for the wireless communications.
ELECTRONIC EQUIPMENT AND ENGINEERING	W27 314	2	30	The organization of <i>design</i> and technology office in industry. The production and assembly of PCBs. Production of microstructures, fat, transistors, diodes and IC. Sensors for electronic equipment. The shields anti EM Fields-materials and construction. The thermo problems in micro-miniatures and electronics equipment. Recycling in electronics.
IMAGE PROCESSING	W27 315	3	60	Basic information about digital image, mathematical model of image, image sampling and quantization, model of noise. Methods of image enhancement by point processing, gradient techniques. Morphological operations. Methods of compression and decompression of digital images. Image recognition methods, patterns and pattern classes. Usefulness of systems of image analysis and recognition.
INFORMATION THEORY	W27 316	2	30	Basis definitions of information theory (information, entropy, joint entropy, conditional entropy). Models of information sources. Memoryless information sources, Markov sources. Shannon's source coding theorem (symbol codes). Model of a non-noisy channel, mutual information, properties of mutual information. Channel capacity-maximum mutual information. Shannon's capacity theorem. Model of a noisy channel. Shannon's fundamental coding theorem. Elements of detection theory. Error-correcting codes. Linear codes - encoding and decoding. Cyclic codes - encoding and decoding. Convolutional codes - encoding and decoding. Vitterbi algorithm.
TELECOMMUNICATION CONTROL SYSTEMS 1	W27 317	2	30	The mathematical background of the control system theory. The telecommunication control systems (TCS) structure, stability, accuracy and noise immunity. The examples of the TCS: PLL, time synchronization systems in telecommunications. Correlation theory of the TCS. The Kalman filters. Synchronization systems with different types of signal coding. Teleinformatic networks synchronization. Systems of automatic time, frequency and space tracking.

Eighth Semester				
MICROCONTROLLER APPLICATIONS 2	W28 318	2	30	Miscellaneous microcontrollers programming: timer/counters, interrupt system, external and internal ADC and DAC converters servicing, serial interfaces (SPI, I2C, UART), keyboard and display servicing, devices sleep modes.
INTERNET TECHNOLOGIES 3	W28 319	3	30	Review of contemporary trends in developing internet services. Programming applications accessible via web servers (Web Services). Transferring content into mobile devices like smartphones and PDAs. WWW pages for personal mobile devices. Transferring streaming media content with web technologies. Displaying streaming media content on WWW pages. Creating presentations for web pages using Flash technology. Deploying selected internet technologies in corporate intranets and extranets.
TCP/IP NETWORKS AND APPLICATIONS 1	W28 320	3	30	Architecture of network systems with TCP/IP protocols and its description with 7-layer OSI model. Structure of the IP packet in version 4 and 6. Methods of addressing of IP network devices: classful addressing, classless addressing with fixed length subnet mask (FLSM) and classless addressing with variable length subnet mask (VLSM). Multicasting addressing. Structure of TCP and UDP protocol data units (PDUs). Connection oriented communication with TCP protocol. Auxiliary network protocols: ICMP, ARP, DHCP and others. Idea of autonomous system (AS). Inter-AS routing with BGP protocol. MPLS protocol and its applications. Network address translation procedure (NAT). Traffic aggregating, splitting and balancing in the TCP/IP networks.
NETWORK APPLICATION PROGRAMMING	W28 321	4	60	Client and server. Berkeley Sockets. Internet protocols: TCP and UDP Remote access services RAS. Windows sockets. Winsock API. Internet programming using Microsoft Foundation Class MFC. Programming threads. Database access: ODBC, ASP, ADO). Java. Introduction to programming in environment .NET; C# language.
TELECOMMUNICATION CONTROL SYSTEMS 2	W28 322	2	30	The computer aided design of the principle blocks of the Telecommunication Control Systems (TCS) using the MATLAB-SIMULINK environment. The analysis of the time and frequency characteristics in linear and non-linear systems. The system parameters correction and optimization in the presence of noises. Analysis of the Kalman filters characteristics.
DATABASE AND DATA WAREHOUSE SYSTEMS 1	W28 323	2	60	Introduction to database and data warehouse systems, basic terminology. History of database systems progress as well as their position and role in informatics system. Concept of relational model of data: modelling of connections, integrity of data. The basics of SQL: definition and modification of data, queries, control of data. Design and management of database: user interface, processing and optimisation of queries, protection, encoding and restoration of data. Problems of design and construction of warehouse: design periods, definition of needs. Trends of database and data warehouse systems progress.
Ninth Semester				
INFORMATION SYSTEMS FOR BUSINESS ENTERPRISES	W29 324	2	30	Information connections of information model of an enterprise. Tasks of informatics system at individual departments of enterprise: accounts, store-rooms, delivery, manufacture, quality control, marketing, customer service, planning and investment, research and development, management. History and generations of integrated MRP/ERP systems for aiding management. Implementation of informatics system: planning, estimate of cost, service and supervision, documentation, quality control. Systems of aiding make a decision. Survey of offered MRP/ERP systems.
WIRELESS NETWORKS	W29 325	3	30	The fundamentals of the wireless network architecture. Principles of the radio waves propagation. Main propagation models. Transmitting and receiving techniques. Digital communication systems GSM, CDMAone, UMTS. Transmission rate. Wireless LAN (WLAN): Standards IEEE 802.11, Bluetooth, HYPERLAN, HomeRF. Protocols of the networks. Satellites communication systems.

SECURITY AND RELIABILITY OF NETWORK SYSTEMS	W29 326	2	30	Sources and types of threats to network systems. Methods of protection against selected kinds of threats. Firewall systems. Antivirus protection. Intrusion detection systems (IDS). Idea of honeypots. Conception of security politics. Examples of complex security politics. Security audit and penetration tests. Security threats to mobile wireless devices. Data backuping and restoring. Methods of authentication and authorization in network systems. Basics of cryptography. Symmetric and asymmetric cipher algorithms like DES and RSA. Idea of Public Key Infrastructure (PKI). Digital signatures. Determining of system reliability. Selected methods for increasing of reliability of network systems: UPS, RAID, cluster systems and others.
INTERNET TECHNOLOGIES 4	W29 327	3	45	Developing applications accessible via web servers (Web Services). Using SOAP protocol and XML for communicating with web services. Creating WWW pages for personal mobile devices like PDA or smartphone. Creating WWW pages with streaming media content. Displaying streaming media content on WWW pages. Creating presentations for web pages using Flash technology. Creating manageable web sites using ASP, JavaScript, SQL database and XML. Creating and testing search systems for own web sites.
TCP/IP NETWORKS AND APPLICATIONS 2	W29 328	3	45	Configuration and technical examination of multisegment IP networks with static and dynamic routing. Configuring route redistribution between different routing protocols. Setting up the IP network with multicast addressing. Configuring routing between VLANs. Configuring the remote access system (RAS). Configuring and technical examining of the IP network with MPLS protocol. Configuring and technical examining of the TCP/IP networks with traffic aggregating, splitting and balancing.
SELECTED TOPICS OF DIGITAL SIGNAL PROCESSING	W29 329	5	60	Signal spaces, models of random and deterministic signals. Examples of deterministic signal processing, 1-D filtering, 2-D filtering. Introduction to signal detection and estimation. Properties of estimators, criteria of optimal signal estimation. Selected methods of optimal digital signal processing. Algorithms of MMSE signal estimation, linear prediction. LMS adaptive algorithms (Widrow-Hoff, Newton algorithms), RLS algorithms. Introduction to time-frequency transforms. Linear time-frequency transforms (STFT, Gabor transform). Quadratic time-frequency transforms (Wigner-Ville, Choi-Williams with exponential kernel Rihaczek, Margeneau-Hill). Applications of time-frequency transforms.
DATABASE AND DATA WAREHOUSE SYSTEMS 2	W29 330	2	30	Standards of SQL language: key words, identifiers, names, notation; connection, transactions; definition and manipulation of data, connectivity of data. Design, programming and implementation of database: modelling of database and constraints, forming and processing of queries, management of memory and transactions.
B.SC. SEMINAR	W94 331	30	30	Presentation of the diploma projects, bring it up for discussion. Analysis of the modern tendencies in telecommunication technologies and teleinformatic networks.
M.SC SEMINAR	W95 332	30	30	Presentation of the diploma projects, bring it up for discussion. Analysis of the modern tendencies in telecommunication technologies and teleinformatic networks. DSP applications, software radio systems. Networks programming.

Specialization: Industrial Electronics

Fourth Semester				
PROCESS MODELLING AND SIMULATION	W34 400	3	60	Fundamentals of process modelling: goals of modelling, system boundaries, physical laws and development of mathematical description, model representation and structure. Classification of physical systems and system modelling techniques. Methods of describing and analysing of dynamic properties of linear and non-linear, continuous and discrete, stationary and non-stationary dynamic plants. Matlab/Simulink programming. Examples of modelling and simulation of physical (mechanical, electrical, etc.) systems.
PROGRAMMABLE INTEGRATED CIRCUITS 1	W34 401	2	30	Review of a digital and analogue single chip devices (FPGA, CPLD, FPAA, ispPAC) in electronic systems. Programmable system on chip (PSOC). CAD tools for designing, modelling and implementation of programmable devices.

Fifth Semester				
PROGRAMMABLE INTEGRATED CIRCUITS 2	W35 402	2	30	Exercises in design using CAD tools for designing, modelling and implementation digital and analogue programmable devices. Computer aided design of application specific integrated circuits (ASIC).
MICROPROCESSOR SYSTEMS 1	W35 403	1	15	Principles of assembler programming and basics of writing and applying procedures, including interrupt service routines. MCS51 as an example of classical single-chip microcomputer family: structure, functioning, instruction list, embeded peripherals and extensions of the standard.
INDUSTRIAL APPLICATIONS OF POWER ELECTRONICS 1	W35 404	2	30	Development and control of power semiconductor devices (fast diodes, SCR, ASCR, RTC, LTT, SITH, MCT thyristors, BJT MOSFET, IGBT, SIT transistors, intelligent power modules. Drivers and electrical isolation (transformers, opto-coupler, optoisolator) of gate drive circuits. Three-phase power net in stationary and rotating reference frames. Three-phase DC/AC converter. Current and voltage measurement circuits. Selected structures of multi-quadrant DC/DC converters. Current and voltage control methods of DC/AC inverter. Lab. frame programme: Control of phase-controlled rectifiers. Phase-controlled rectifiers with different type of load. Investigation of multi-quadrant DC/DC inverters. Regulation of three-phase DC/AC inverter output parameters.
MECHATRONICS 1	W35 405	3	45	The some elementary principles of mechanics. The mathematical model of the separately excited DC machine and structure of the control system. Mathematical model of the three-phase induction machine and basic structure of the vector control drive systems (FOC, DFOC, DTC). Mathematical model of the synchronous machine. Variable frequency synchronous motor drives. Basic properties of servo-drive systems. The position and speed sensors.
Sixth Semester				
MICROPROCESSOR SYSTEMS 2	W36 406	2	30	Practical exercises in programming of MCS51: arithmetic, subroutines, interrupts, embedded and external device service.
MECHATRONICS 2	W36 407	2	30	The laboratory investigation of the servo-drives systems with DC machines, induction machines and synchronous machines. The laboratory investigations of speed and position sensors.
INDUSTRY DIGITAL SYSTEMS	W36 408	3	45	The structure of industry digital systems, basic definitions, special and universal digital systems. Real time systems: the structure, principles of operation; data transmission systems, A/C and C/A conversion, man-machine interface, programming. The microprocessor and PLC control in drive systems.
AUTOMATIC CONTROL TECHNIQUES 3	W36 409	2	30	The subject covers methods of describing and analysing dynamic properties of controlled plants, and linear and non-linear, continues and discrete automatic control systems. During the laboratory sessions, among others, typical automatic systems with PID controllers, digital controllers and relay control systems are studied.
MICROPROCESSOR TECHNIQUES IN INDUSTRIAL ELECTRONICS 1	W36 410	3	45	The microprocessor system functions in power electronics structures. MSC-51 microcontroller family and its modifications architecture. Software and hardware aid tools. Writing and testing software for arithmetic functions of multibyte numbers. Software realization of selected controllers. Writing software for advanced microcontrollers peripheral blocks. Selected functional blocks realization for power electronics and electrical drive applications: angular speed measurements, phase controllers, pulse width modulators etc.
COMPONENTS OF AUTOMATIC CONTROL	W36 411	4	60	Low-power engines, DC and AC motors, synchronous and asynchronous, stepper, brushless and special motors. Basic magnetic elements. Selected elements of measuring systems. Linear and nonlinear controllers. Active and digitally tuned filters. Position and angular velocity measurement systems. Problems of galvanic separation.
PROGRAMMABLE LOGICAL CONTROLLERS AND PROCESS CONROLERS	W36 412	3	45	The structure of industry digital systems. Programmable logical controller: structure, principles of operation, programming languages, I/O digital and analog modules. Process controllers: complex closed loop systems, control functions, technical characteristics of some PID and multifunction controllers.

Seventh Semester				
METHODS OF PROCESSES IDENTIFICATION	W37 413	5	60	Models of controlled plants and parameter estimation methods. LS estimators. Recurrence networks for processing measurement data and for identifying dynamic plants. Typical testing signals. Statistic tasks with a view to problems of on line supervision. Stochastic detection algorithms. Problem of concisely sending current information to dispatcher. Inspection of process by means of key quantities. Characteristics of typical software packages used for experimental data handling.
DIGITAL CONTROL SYSTEMS	W37 414	2	30	In the programme the aim is to widen the theoretical knowledge of the students and develop their skill in solving practical tasks in the field of digital control systems. It covers: chosen problems of analysis and synthesis of control systems using A transfer function and a state space equations model, describing the stochastic influence of the environment on the controlled plant.
DYNAMIC OF THE MECHATRONICS SYSTEMS 1	W37 415	2	30	Advanced control methods of electrical drive systems. Synthesis of the current control lop and speed control loop in AC drives. Control with the use of observers and adaptive methods. The sensitivity and robust analysis of mechatronics systems. The stability analysis of the drives systems. The sensor-less drive systems. Linear position control. Linear position control with moving target. The optimal position control.
COMPONENTS OF INDUSTRIAL ELECTRONICS 1	W37 416	2	30	Operating amplifiers, basic configurations, mathematical description, practical applications, digitally controlled scheme. Measuring amplifiers. The basic topologies of continuous and digital regulators. Regulators with and without interaction. The second and higher order active filters. Active filters tuned digitally. Chosen configurations and applications of non-linear scheme: limiters, precise rectifiers, phase detectors and variables or sign gain circuits. The function multiplier, divide and extracting of a root scheme. Processing and standardization of analog signals. Converters A/D and D/A. Galvanized isolation in measuring circuit. Scheme of coupling with microprocessors systems and measuring sensors. Analog and analog-digital circuits processing of vectorial values. The multi-channel and single-channel phase controllers and team controllers the direct frequency changers. The problems of synchronization and noise immunity. Structure and function the digital and analog-digital systems of measurement rotational speed and position, examples of ASIC realization. The phase lucked loop systems to filtration and reconstruction of net phase voltage. Simple programmable systems of PAL, GAL and PLA. Structure of cicuits PLD, CPLD and FPGA. The application of programmable circuit to building distributors of impulses inverters and indirect frequency changers. Secondary sources of power supply with galvanized separation of the electronic circuits.
Eighth Semester				
DYNAMIC OF THE MECHATRONICS SYSTEMS 2	W38 417	2	30	The laboratory investigation of the servo-drives systems with DC machines, induction machines and synchronous machines. The laboratory investigations of the sensitivity of the mechatronics systems. The laboratory investigations of the stability of the mechatronics systems.
COMPONENTS OF INDUSTRIAL ELECTRONICS 2	W38 418	3	30	Investigation of system solutions and method of working components of analog-digital velocity regulator direct-current motor. The realization of digital components in PLD structures the peculiarity: the impulses commutator of AC/DC and DC/AC inverter, anticoincidence arrangement, adder number of switching switches of three phase DC/AC and AC/DC inverter. Built and programming simple binary programmer on the basis single-chip microcontroller type 8048/49 and its investigation. The microcontroller realization of programmer PWM on the base of single-chip 8051 microcontroller. Investigation and analysis of systemic solutions programmable the digital signal source. Analogue-digital signal source of vectorial magnitudes, generators of polyphasic periodical signals with controllable parameters. Analysis of single-channel programmer of direct frequency channger. Investigation of circuit to reproduction phase of line voltage with phase locked loop PLL. Analysis of possibility of usage in circuits the digital adders steering of induction motor.

REAL TIME SYSTEMS	W38 419	3	45	Computer-based control of industrial plants: requirements and typical hardware and software architectures. Real-time operating systems: kernel architecture, multitasking, input-output subsystem, file system, task scheduling and control, communication and synchronization, networking technologies, interrupt handling, memory management, system database. Commercial real-time operating systems: QNX, OS/9, RTLinux, VxWorks. Real time programming and real-time programming languages. Real time operating systems in industrial control architecture – communication with programmable controllers, PLCs,, sensors and actuators. Human-machine interface – visual interface in real-time environment, POSIX standard.
METHODS OF PROCESS OPTIMIZATION AND DIAGNOSTICS	W38420	4	60	Classification of problems of the optimization theory. Introduction to non-linear programming: necessary and sufficient conditions for function extrema, iterative schemes of minimisation of a cost function. Non-constrained and constrained optimization problems. Multi-criteria optimization problems. Practical examples of static optimization problems. Introduction to optimal control theory; problem statement, dynamic programming, Pontryagin's principle. Time-optimal control problems. LQR controller design. Basic methods of fault detection and isolation (FDI). Typical monitoring tasks; diagnostic signals, symptom-fault relations, diagnostic matrices. Methods of residua generation and feature extraction. Pattern recognition for system diagnostics: classical and AI methods, decision trees, Bayesian classifiers. Examples of computer-aided process diagnostics.
POWER ELECTRONICS – SELECTED PROBLEMS 1	W38 421	2	30	Protection of semiconductor devices from overvoltage, overcurrent and short circuit. Serial and parallel work of semiconductor devices. Cooling of power electronics systems. Direct frequency changers. Vectorial methods of current and voltage control. Criteria of evaluation of power electronics converter control methods. Linear and non-linear control methods of AC/DC and DC/AC converter. Fuzzy logic and neural network control. Direct torque control (DTC) and direct self control (DSC) of PWM inverter-fed induction motor drives. AC/DC converter with input power coefficient equal one. Active and passive compensation of reactive power.
INTEGRATED CONTROL SYSTEMS 1	W38 422	2	30	Structure of power industry digital systems, basic definition, special and universal digital systems. Real time systems – structure, principle of operation, data transmission systems, A/C and C/A conversion, human – machine interface, programming. PLC - structure, principle of operation, control functions, programming languages, I/O digital and analog modules. Examples of PLC and BMS control systems.
Ninth Semester				
MICROPROCESSOR TECHNIQUES IN INDUSTRIAL ELECTRONICS 2	W39 423	4	45	Base structures of fixed-point microprocessors (DSP). ADSP-21xx processor, architecture and feature. The ADSP-21xx as a core of ADMC chips dedicated for power electronics and electrical drive applications. Learn about of ADMC-401 microcontroller. Microcontroller architecture, algebraic language of assembler, programming tools. Internal microcontrollers peripheral, feature and programming methods. Base rules of DSP processors programming. Selected functional blocks realization for power electronics and electrical drive applications: digital filters, digital controllers (P, PI, PID), vectorial coordinate conversion. Running and testing written software using research stations.
POWER ELECTRONICS – SELECTED PROBLEMS 2	W39 424	4	60	Reversible phase-controlled rectifier. Thyristors DC/DC inverter. Investigation of three-phase AC/AC converter. Direct torque control (DTC) of inverter-fed induction motor drive. Voltage and current control of DC/AC inverter. AC/DC converter control with unitary power factor. Investigation of UPS. Investigation of DC/AC inverter SAMI GS fed AC motor.
INTEGRATED CONTROL SYSTEMS 2	W39 425	2	30	Structure of power industry digital systems, basic definition, special and universal digital systems. Real time systems – structure, principle of operation, data transmission systems, A/C and C/A conversion, human – machine interface, programming. PLC - structure, principle of operation, control functions, programming languages, I/O digital and analog modules. Examples of PLC and BMS control systems.

MODERN METHODS OF CONTROL	W39 426	2	30	Introduction to theory of dynamic optimisation and optimal control; the LQR and LQG control theory, and introduction to prediction control. The problems of robust control and the rules of robust controller construction. Elementary theory of fuzzy sets. FLC regulators. Chosen version of prediction control. Adaptation control. Modelling and analysing of adaptation systems. Application of neural networks for recognition, identification and control purposes. The role of simulation studies with examples.
METHODS OF ARTIFICIAL INTELLIGENCE	W39 427	4	60	Artificial neural networks: model of an artificial neuron, typical architectures of feedforward, RBF and competitive networks. Supervised and unsupervised training algorithms. Typical applications of neural networks: classification, pattern recognition, modeling of dynamic systems, data compression, feature extraction, system identification, control, diagnostics. Fuzzy sets and fuzzy systems – fuzzy approximation, classification, modeling and control. Neuro-fuzzy systems. Genetic algorithms and genetic programming. Rough sets – data representation, attributes and relations. Rough sets in data classification and pattern recognition.
OBJECT - ORIENTED PROGRAMMING	W39 428	2	30	Structural and object-oriented programming. Introduction to programming in language C++. Standard libraries. Streams. Templates of classes and functions, namespaces, exceptions. Standard Template Library (STL). Application of environmental mechanisms. Class libraries dependent on operational environment.
ELECTIVE SUBJECT	W39 429	2	30	
B.SC. SEMINAR	W96 430	30	30	Subject and goals of the particular M.A.thesis initial presentation. Discussion on M. A. thesis: form, contents and method of writing. Individual presentation and discussion of worked out papers concerning realized M. A. thesis. M. A. depme form, area and assessment methods discussion.
M.SC SEMINAR	W97 436	30	30	Subject and goals of the particular M.A.thesis initial presentation. Discussion on M. A. thesis: form, contents and method of writing. Individual presentation and discussion of worked out papers concerning realized M. A. thesis. M. A. depme form, area and assessment methods discussion.

Elective subject

DESIGN AND CONSTRUCTION OF INDUSTRIAL ELECTRONICS COMPONENTS	W39 450	2	30	Design, construction, starting and testing selected or prototyped electronics components. The application of middle and high scale integrations chips (especially microprocessors and programmable devices) to designed projects. Computer-aided tools for prototyping and testing are used.
SELECTED SOFTWARE FOR COMPUTER AIDED DESIGNING	W39 451	2	30	Base rules of drawing, positioning and describing of schematics diagram elements. Technical terms for interconnections between schematics diagram and printed circuit board (net list). Base rules for locating chips stamps on printed circuit board. Creating multilayer printed circuit board from schematics diagram. Optimization PCB such as: chips stamps location, connections and functionality of PCB project. The introduction to Matlab-Simulink application software. Describing extended libraries (Toolboxes). Describing selected elements form “PowerSystemBlockset” library (for example: DC drive models, AC drive models, transformer models, generators, modulators, power modules, sensors etc.). Realization and simulation of selected problems.
MODERN INDUSTRIAL PROCESSES	W39 452	2	30	Plastic technology. Glue technology. Ultrasound technology. Powder technology. Modern technologies of heating and drying and joining.

Specialization: Optoelectronics

Fourth Semester				
FUNDAMENTALS OF LIGHTING ENGINEERING 1	W44 500	2	60	Electromagnetic radiation quality and quantity parameters. Eye and vision. The basics of photometry - spectral luminous efficiency $V(\lambda)$. Daylighting. Characteristics of electric light sources (tungsten, tungsten halogen, fluorescent, high pressure discharge: mercury vapour, metal halide, sodium). Lighting methods – direct, indirect, mixed. Parameters and classification of luminaires.
INSTRUMENTAL OPTICS 1	W44 501	2	45	Geometrical optics, ideal optical systems, rays propagation in optical system, pupils and stop diaphragm, eye characteristics, geometrical theory of aberrations, image quality assessment, basic characteristic of optical instruments (microscope, telescope, projection system).
Fifth Semester				
FUNDAMENTALS OF LIGHTING ENGINEERING 2	W45 502	1	30	Laboratory tests concerning photometry parameters and laws, parameters of light sources, colorimetry, illumination quality.
INSTRUMENTAL OPTICS 2	W45 503	1	15	Focal length measurement. Refractive index measurement. Rectilinearity of optical bench. Setting-up the microscope, telescope, projecting configuration. Photoelectric relay system. Operating qualities of biological microscope.
FUNDAMENTALS OF PHOTOMETRY 1	W45 504	1	15	Measurement methods in photometry. Photometric laboratory, measure devices, standards. Measurement errors, methods of determination. Photoelectric detectors. General photometry measurements of luminous intensity, luminous flux, luminance, illuminance, reflectance, absorptance, transmittance. Photometric, radiometric, spectrophotometric and colorimetric measurements. The calibration of photometric instruments.
OPTICAL FIBRES 1	W45 505	2	45	Basics of optical fibres. Multi- and single-mode optical fibres. The theory of electromagnetic waves' modes in optical dielectric fibres. Dispersion in optical fibres, the speed of information flow. The optimization of the refraction coefficient for light. Losses in optical fibres. Optical polarization fibres. Measurement of basic parameters in optical fibres. Qualitative tests. Main application areas.
OPTICAL FIBRE TECHNOLOGY 1	W45 506	2	45	Materials used in optical fibre production. Methods of optical fibres production. Technological equipment. The protection of optical fibres against the influence of external factors. Durability tests. Production methods of optical polarization fibres for sensor applications.
Sixth Semester				
PROJECT WORK	W46 507	2	30	The projects include computer simulation, testing and measurement of optical and electrical properties of photonic devices.
OPTICAL FIBRE TECHNOLOGY 2	W46 508	2	30	Calculations of basic parameters of optical fibres. The evaluation of glass parameters on the basis of chemical composition. The determination of parameters of optical fibres production processes. The mechanical properties of fibres. The fibre production by means of rod-in-tube and crucible method, production of fibre bundles and facing fibres.
OPTO-MECHANICAL SYSTEMS DESIGN 1.	W46 509	4	45	Opto-mechanical design process, environmental influences, optomechanical characteristics of materials, mounting of individual lenses and systems, mounting of mirrors and plates, integral mountings, adjustment of optical instruments.
APPLICATIONS OF OPTICAL FIBRES	W46 510	3	30	Types of optical fibres. The applications of optical fibres in telecommunications, medicine, automatics and robotics, scientific equipment, military technique.
FIBER OPTIC SENSORS	W46 511	6	75	Influence of physics fields on optical fibre. The classification of fiber optic sensors. Intensity based fiber optic sensors. Spectrally based fiber optic sensors. Interferometric fiber optic sensors. Polarimetric optical fiber sensors. Distributed fiber optic sensors.
FUNDAMENTALS OF PHOTOMETRY 2	W46 512	1	15	The measurement of characteristics of photodetectors. The determination of electric and radiant characteristics of light emitting diodes and semiconductor lasers. The calibration of an illuminance meter.
OPTICAL FIBRES 2	W46 513	1	15	The measurement of optical fibre numerical aperture, measurement of optical fibre geometry and measurement of the parameters of optical fibre bundles.

Seventh Semester				
WAVE THEORY OF LIGHT 1	W47 514	3	30	Diffraction and diffraction imaging theory. Optical transfer function. Polarization and polarizing elements. phase plates, wave optics, interferometry, interferometers, interference filters, diffraction, diffraction imaging theory, birefringence, resolution of optical systems from point of view of diffraction theory, optical transfer function, optical materials
PHYSICS LASERS	W47 515	1	15	Radiation of thermal and laser sources – similarities and differences. Laser generator – construction, working conditions, some solutions of laser technology elements. Three- and four-level model of a laser medium. Population inversion, gain. Methods of population inversion creation. He-Ne laser – energy level diagram, construction, parameters, selected applications. CO ₂ laser - energy level diagram, construction, parameters, selected applications. Fiber lasers and amplifiers. Methods of pulse generation. Semiconductor lasers – construction, parameters. Methods of frequency stabilization of generated radiation – frequency standards.
RADIATION DETECTORS 1	W47 516	2	30	Detection of optical radiation – physical phenomenon utilized in detection, detector classification, construction solution of some detectors. Photon detectors: light-sensitive materials, photodiodes, photomultipliers, image amplifiers, spectral-sensitive superconductive detectors. Thermal detectors: thermocouples, bolometers, superconductive detectors – the rule of working, characteristics. Detector matrixes – selected constructions and applications. Complex detection methods – synchronous detection, light-sensitive, homodyne and heterodyne.
OPTO-MECHANICAL SYSTEMS DESIGN 2	W47 517	2	30	The optical measuring instruments and systems. Methods of testing the image quality and influence of environmental conditions on the operational quality and safety of optical instruments. Materials for mechanical components.
OPTICAL FIBRES 3	W47 518	3	45	The optical fibre broadcasting track. The fibre optic cable construction. Optical fibre broadcasting systems. Regeneration of the optical signal. Far-reaching optical fibre nets. Local networks. Integrated systems. Measurement in optical fibre networks. Main trends in the development of optical fibre networks.
Eighth Semester				
WAVE THEORY OF LIGHT 2	W48 519	2	30	Polarizing-interferometer microscope Biolar PI. Microscope with phase contrast. Optical transfer function. Polarization and polarizing elements. Birefringent media. Diffraction and diffraction imaging theory. Diffraction gratings. Spatial frequencies filtering. Resolution of optical systems. Interferometry and interferometers.
OPTICAL METHODS OF LABORATORY ANALYSIS 1	W48520	1	15	Radiation absorption laws. Practical aspects of radiation absorption laws: influence of light source non-monochromatics on linearity of the photometer, range selection of measured absorbance. Measurements of substance concentrations in multicomponent solutions. Classification of systems used in absorption photometry. Emission flame photometry: principle of the flame photometry, application of internal standards in flame photometers. Application of reflectance methods in quick analytical diagnostics. Application of optical methods in analytic medical equipment.
RADIATION DETECTORS 2	W48 521	1	15	Measurement of electrical and optical properties of optical detectors. Detecting systems.
PHOTONICS 1	W48 522	4	45	Introduction to photonics. Basics of optical phenomenon in semiconductors. Low-dimensional structures – the rule of the use of quantum wells in semiconductor radiation emitters. Forbidden gap engineering – supernetworks. Interface in photonic structures. VCSEL laser systems – basics of construction and selected construction solutions. Construction and selected applications of matrix sources and detectors based on low-dimensional structures. Periodic optical structures – construction of selected elements, methods of analysis and perspectives of development. Optical logic elements. Displays. Optical memory elements.
OPTICAL FIBRES 4	W48 523	2	30	Measurement in optical fibre networks (attenuation, detection of various events by OTDR reflectometer). Optical fibre cables and joints. Optical modulators. Insulators and optical circulators. Mechanical strength of fibres.

SEMICONDUCTOR LIGHT 1	W48 524	2	30	Characteristics of optical semiconductor materials. Band-structure of semiconductors. Radiative and non-radiative transitions. Basic semiconductor materials, emission properties. Optical phenomenon in semiconductors. Population of levels. Construction and characteristics of LED diode, applied materials, construction and technology. Semiconductor lasers. Methods of population inversion creation. Laser diodes – construction of edge-emitters and VCSEL. Generation conditions. Laser resonator construction. Construction of selected radiation sources. Characteristics of laser beams. Spectral and thermal characteristics. Selected applications. Semiconductor laser technology. High power semiconductor lasers. Classification, generation methods. Construction specificity of high power semiconductor laser sources – cooling systems, line and matrixes of emitters. Launching of radiation sources with optical fibers. New construction of semiconductor emitters. Single-frequency generation. Quantum well theory and its application in semiconductor lasers. Tuning methods of laser radiation wavelength.
MICROPROCESSOR TECHNIQUE IN POWER ELECTRONICS AND OPTOELECTRONICS 1	W48 525	2	30	Base structures of fixed-point microprocessors (DSP). ADSP-21xx processor, architecture and feature. The ADSP-21xx as a core of ADMC chips dedicated for power electronics and electrical drive applications. Learn about of ADMC-401 microcontroller. Microcontroller architecture, algebraic language of assembler, programming tools. Internal microcontrollers peripheral, feature and programming methods. Base rules of DSP processors programming. Selected functional blocks realization for power electronics and electrical drive applications: digital filters, digital controllers (P, PI, PID), vectorial coordinate conversion. Running and testing written software using research stations.
IMAGE DETECTORS	W48 526	2	30	Optical design process, environmental influences, optical characteristics of materials, optical elements and assemblies, optical instruments, optical quality methods and testing, surface analyzing optical detectors, CCD camera, fitting of light emitter, light transferring and transforming system and detector characteristics
Ninth Semester				
INTEGRATED OPTOELECTRONICS	W49 527	4	45	Planar optical wave-guides. Monocrystalline and polycrystalline materials used in integrated optics – characteristics, technology, exemplary applications. Technology of integrated optics elements. Methods of integration of optoelectronic systems of integrated optics. Modulators and filters used in integrated optics systems. Logic elements – the state of the art and perspectives.
PHOTOVOLTAIC TECHNIQUES	W49 528	4	45	Optical phenomenon in semiconductors. Photovoltaic phenomenon – analysis of solar cell parameters, materials used in photovoltaic systems. Monocrystalline and polycrystalline solar cells. Alternative methods of utilizing solar energy in photovoltaic systems – exemplary solutions. Electronics systems interacting with solar cells in photovoltaic systems – inverters, accumulators, fuel cells. Membranes and super-ionic conductors used in storage and energy conversion systems.
OPTICAL METHODS OF LABORATORY ANALYSIS 2	W49 529	1	15	Practical aspects of radiation absorption laws: influence of light source non-monochromatics on linearity of photometer, absorbance and concentration measurement problems in photometers. Construction of spectrophotometers and absorption photometers. Emission flame photometry. Principle of flame photometry, examples of design solutions, substance concentration measurements. Concentration measurements methods using dry tests. Construction of reflectometers for instance of glucose concentration meter.
BROAD-BAND OPTICAL FIBER NETWORKS	W49 530	2	30	Wavelength-Division Multiplexed (WDM) and dense-wavelength-division multiplexing (DWDM) transmission systems. Network control methods, service and application areas. Passive and active network elements. Multi-wavelength sources, wavelength de-multiplexers, tuneable filters and optical switching to build networking elements. The role of wideband optical fibre amplifiers, DWDM devices in fibre communications systems and optical networks. Applications of DWDM systems in long-haul trunking networks, metropolitan networks.
PHOTONICS 2	W49 531	1	15	Photons as information carriers. The parallel processing of information. The architecture of optical computers. Optical and optoelectronic memories. Electrooptic, magneto optic, and acousto optic modulators. Photonic logical devices. Optical processors. Photonic transmitting buses.

INTEGRATED CONTROL SYSTEMS	W49 532	3	45	Structure of power industry digital systems, basic definition, special and universal digital systems. Real time systems – structure, principle of operation, data transmission systems, A/C and C/A conversion, human – machine interface, programming. PLC - structure, principle of operation, control functions, programming languages, I/O digital and analog modules. Examples of PLC and BMS control systems.
SEMICONDUCTOR LIGHT 2	W49 533	1	15	Measurement of electrical and optical properties of optical semiconductor.
MICROPROCESSOR TECHNIQUE IN POWER ELECTRONICS AND OPTOELECTRONICS 2	W49 534	2	30	Base structures of fixed-point microprocessors (DSP). ADSP-21xx processor, architecture and feature. The ADSP-21xx as a core of ADMC chips dedicated for power electronics and electrical drive applications. Learn about of ADMC-401 microcontroller. Microcontroller architecture, algebraic language of assembler, programming tools. Internal microcontrollers peripheral, feature and programming methods. Base rules of DSP processors programming. Selected functional blocks realization for power electronics and electrical drive applications: digital filters, digital controllers (P, PI, PID), vectorial coordinate conversion. Running and testing written software using research stations.
COMPUTER DESIGNING OF OPTOELECTRONICS SYSTEMS	W49 535	2	30	Designing optoelectronic units (LED diode, IR diode), Bragg's meshes, optoelectronic systems, EDFA optical amplifiers, polaryzation optical fibres. Designing optical fibres which it gives the parameters of release of power radiation.
B.SC. SEMINAR	W98 536	30	30	Each student makes two reports. The subjects of the reports are disscsed during the seminars
M.SC SEMINAR	W99 537	30	30	Each student makes two reports. The subjects of the reports are disscsed during the seminars