FACULTY OF ELECTRICAL ENGINEERING,
COMPUTER SCIENCE AND TELECOMMUNICATIONS

ERASMUS PROGRAMME

GENERAL DESCRIPTION AND ECTS SCORING FOR FIELDS OF STUDY:

CONTROL ENGINEERING AND ROBOTICS

UNDERGRADUATE PROGRAMME

Collected and prepared for printing by

MACIEJ PATAN

NUMERICAL METHODS

Course code: 11.9-WE-AIR-MN-PP16_S1S

Type of course: compulsory

Entry requirements: Mathematical analysis
Mathematical foundations of engineering

Language of instruction: English

Director of studies: Prof. Andrzej Obuchowicz

Name of lecturer: Prof. Dariusz Uciński
lecturers WEIiT ISSI

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	15	1	II	Grade	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	9	1	II	Grade	
Laboratory	18	2		Grade	

COURSE CONTENTS:

Mathematical foundations. Elementary definitions and theorems from mathematical analysis used in numerical computations; Taylor series.

Errors and number representation. Sources and types of numerical errors; numerical conditioning and stability, techniques of error avoidance; binary, decimal and hexadecimal systems; fixed and floating point representations.

Solving nonlinear algebraic equations. Methods: bisection, Newton, secant, falsi; application of fixed-point theorem; analysis and estimation of errors; extrapolation; ill-conditioning and stability of solutions.

Solving systems of linear equations. Gaussian elimination; choice of a leading coefficient; LU factorization; estimation of errors and numerical stability; recursive methods: Jacobi and Gauss-Seidel iterations.

Interpolation. Characteristics of interpolation and its applications; polynomial interpolation, spline interpolation.

Approximation. Least squares method; minimax error, orthogonal polynomials.

Numerical integration. Newton-Cotes and Gauss quadratures, analysis and error estimation.

Solving ordinary differential equations. Methods: Euler, Runge-Kutta, corrector-predictor.

Elements of linear programming. Definition of LP task; algorithms for solving LP tasks. Transportation and assignment problems.

Basics of nonlinear programming. Lagrange method; directional search techniques; iterative algorithms: non-gradient, gradient based, and quasi-Newton type. Constraints.

LEARNING OUTCOMES:

Skills and competences in: solving problems formulated in a form of mathematical models; applying mathematical description for static and dynamic processes; formulation of uncertainty description; analysis of dependence of computation results on numerical errors; creative usage of numerical packages.

ASSESSMENT CRITERIA:

Lecture – the passing condition is to obtain positive marks from all tests, which take place at least once per semester;

Laboratory – the passing condition is to obtain positive marks from all laboratory exercises to be planned within the laboratory schedule.

RECOMMENDED READING:

1. Recktenwald G..: *Numerical Methods with MATLAB: Implementations and Applications*, Prentice Hall, 2000
2. Press W., Teukolsky S., Vetterling W., Flannery B.: *Numerical Recipes: The Art of Scientific Computing* , *3rd Edition,* Cambridge University Press, 2007
3. Atkinson K.: *Elementary numerical analysis*, Wiley& Sons, New York, 1993.
4. Hamming R.: *Numerical Methods for Scientists and Engineers*, Dover Publications, 1987.
5. Isaacson E.: *Analysis of Numerical Methods*, Dover Publications, 1994.
6. Chapra S., Canale R.: *Numerical Methods for Engineers*, McGraw-Hill Higher Education, 2005.
7. Hillier F.: *Introduction to Operations Research*, McGraw-Hill, 2009

OPTIONAL READING:

REMARKS:

OPERATING SYSTEMS AND COMPUTER NETWORKS I

Course code: 11.4-WE-AiR-SOS2-PD_S1S
Type of course: compulsory
Entry requirements: Computer System Architecture
Language of instruction: Polish/English
Director of studies: Prof. Krzysztof Patan
Name of lecturer: Prof. Krzysztof Patan

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					1
Laboratory	15	1	III	grade	
Part-time studies					
Laboratory	9	1	III	grade	

COURSE CONTENTS:

Computer system structure: Operating memory, procesor, CPU, I/O devices, idea of the interupt, dual model of system operation
Operating systems types: Batch systems, multiprogramming systems, time-sharing (multi-tasking) systems, parallel systems, distributed systems, networked systems real-time operating systems.
Operating systems design. Basic components of operating systems. Operating systems services. Kernel based systems, virtual machines. System calls.
CPU scheduling. Scheduling criteria, scheduling algorithms. Evaluation of scheduling algorithms. Round robin, priority scheduling, preemptive scheduling.
Memory management. Logical and physical addresses space. Contiguous allocation. Fragmentation: external and internal. Packing. Paging. Segmentation.
Virtual memory. Demand paging. Page replacement. Performance of demand paging. Algorithms of page replacement. Allocation of frames. Demand segmentation.

File system. File concept. Directory structure. File system structure. Allocation methods. Free-space management. File system structure.

Introduction to computer networks. Model ISO/OSI. Reference model TCP/IP, network devices. Computer network topologies: token ring, star topology, hierarchical networks, per to per networks, LAN, WAN networks.

Routing and addresses. Routers: structure and idea of operation, routing protocols, routing tables.

LEARNING OUTCOMES:

Skills and competences in computer systems and operating systems design. To learn about process scheduling, memory management, file system design. Competences in computer network topologies and communication protocols. Basic knowledge about network devices: router, switch, hub. Ability to configure the computer and operating system to work in the computer network.

ASSESSMENT CRITERIA:

Lecture – the passing condition is to obtain a positive mark from the final test.

RECOMMENDED READING:

1. Silberschatz A., Galvin P.B., Gagne G.: *Operating system concepts. Seventh Edition*, Wiley, 2005.
2. Tanenbaum A.: *Modern operating systems*, Prentice Hall, 2001.
3. Sportack M.:*Networking Essentials: Concepts and Practice*, Pearson Higher Education & Professional Group, ISBN 1580760090 (1-58076-0.
4. Solomon D.A., Russinovich M.E.: *Microsoft Windows 2000. Od środka*, Helion, Gliwice, 2003.
5.Morimoto R.,Noel M., Droubi O., Żardinier K., Neal N.: *Windows Server 2003. Księga eksperta*, Helion, Gliwice, 2004.
6.Johnson M.K., Troan E.W., *Oprogramowanie użytkowe w systemie LINUX*, WNT, Warszawa, 2000.

OPTIONAL READING:

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REMARKS:

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ARTIFICIAL INTELLIGENCE METHODS

Course code: 11.4-WE-AIR-MSI-PP21_S1S

Type of course: compulsory

Entry requirements: Mathematical analysis, Foundations o discrete systems, Linear algebra with analytic geometry

Language of instruction: English

Director of studies: Prof. Andrzej Obuchowicz

Name of lecturer: Prof. Andrzej Obuchowicz, lecturers WEIiT ISSI

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	15	1	III	Exam	
Laboratory	15	1		Grade	
Part-time studies					
Lecture	9	1	III	Exam	
Laboratory	9	1		Grade	

COURSE CONTENTS:

Artificial intelligence (AI). What is AI? Historical outline. Samples of AI applications. Touring test. Concept of perception and learning. Software dedicated to AI algorithms realization: Prolog, LISP, CLISP languages, Exsys system.

Solving problems by searching. Formulation of the searching problems and searching spaces. Search strategies for graphs: breadth-first search, depth-first search, depth-limited search, iterative deepening search, bidirectional search. Heuristic functions. A* algorithm, iterative deepening A* search, hill-climbing search, simulated annealing and tabu search. Constraint satisfaction search

Games. Games and search problems. Two-person games: perfect and imperfect decisions, evaluation functions, cutting off search. Alpha-beta pruning. Games that include an element of chance.

Knowledge and reasoning. Representation of knowledge, reasoning and logic. First-order logic: syntax, semantics, rules of inference. Uncertain knowledge and reasoning. Building a knowledge base. Logical reasoning systems

Foundations of image recognition. Image filtering. Edge detection. Image segmentation. Image classification and clustering.

Foundations of intelligent computation. Artificial neural networks (ANNs): biological inspiration, models of neuron, ANNs classes and their basic learning processes, samples of ANN applications. Evolutionary algorithms (EAs): basic concepts, general outcome of EAs, standard EAs, samples of EA applications.

LEARNING OUTCOMES:

Basic knowledge of knowledge representations, basic searching methods, learning systems; engineering skills in implementing simple two-person games as well as basic neural network learning techniques and evolutionary algorithms.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the main condition to get a pass is scoring sufficient marks for all laboratory exercices.

RECOMMENDED READING:

1. Russell S. J.: *Artificial Intelligence – A Modern Aprroach* , Prentice Hall, New Jersey, 1995.
2. Michalewicz Z.: *Genetic Algorithms + Data Structures = Evolution Programs*, Springer-Verlag, Berlin Heidelberg, 1996
3. Rich E.: *Artificial Intelligence*, McGraw-Hill Book Company, New York, 1983

OPTIONAL READING:

REMARKS:

DATABASES

Course code: 11.3-WE-AIR-BD-PP22_S1S
Type of course: compulsory
Entry requirements:
Language of instruction: Polish
Director of studies: Dr. Artur Gramacki
Name of lecturer: Dr. Artur Gramacki

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	15	1	IV	Grade	
Class					
Laboratory	15	1		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	15	1	IV	Grade	
Class					
Laboratory	15	1		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Introduction. Database terminology. Basic properties of databases. Requirements for up-to-date databases. Different types of database models (relational, object-relational, object, XML-based, hierarchical, network). The Online Transaction Processing (OLTP) databases, Online Analytical Processing (OLAP) databases. 2-tier and 3-tier architectures. Overview of techniques and tools for creating database applications. Current Relational Database Management Systems (RDBMS).

Entity relationship modeling. Introduction to relational data models. Introduction to modeling and design of information systems, especially relational ones. Definition of an entity. Definition of a relation and its basic properties. Entity-relationship modeling. Basic operations on relations (selection, projection, natural joins, outer joins, other types of joins, cartesian product, grouping, unions). Transformation of entity-based models into relational ones. Primary keys, foreign keys, database constraints (unique, null/not null, check). Database normalization and normal forms, Functional dependency. Indexes.

SQL language and query optimization. SQL as a standard access method to data stored in relational databases. Data Manipulating Language DML (INSERT, UPDATE, DELETE statements), Data Definition Language DDL (CREATE, ALTER, DROP statements), Database Control Language DCL (GRANT, REVOKE statements), Transaction Control Language TCL (COMMIT, ROLLBACK, SAVEPOINT, SET TRANSACTION statements). SELECT statement. Creating of database constraints in SQL. Table joins. SQL functions (character, numeric, datatime). Data grouping. Subqueries. Introduction to transactions. Introduction to query optimization and query tuning.

Security in databases. Data import and export. Creating backups and data recovery. Database logs. Database consistency and integrity. Different strategies of data backup and recovery (full, partial, incremental, point-in-time recovery).

LEARNING OUTCOMES:

Design and implementation of relational models. SQL language. Engineering skills in design and implementation of database applications; basic knowledge of selected Relational Database Management Systems (RDBMS).

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the main condition to get a pass is scoring sufficient marks for all laboratory exercises.

RECOMMENDED READING:

1. Date C.J.: An Introduction to Database Systems, 6th Edition. Addison-Wesley, 1995
2. Garcia-Molina H., Ullman J.D., Widom J.: Database Systems: The Complete Book, Prentice Hall, 2007
3. Ullman J.D., Widom J.: A First Course in Database Systems, 3nd Edition, Prentice Hall, 2001
4. Date C.J., Darwin H.: Guide to SQL Standard, 4th Edition, Addison-Wesley, 1997.

OPTIONAL READING:

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REMARKS:

ELECTRICAL ENGINEERING PRINCIPLES

Course code:	06.2-WE-AiR-PEch-PK_S1S
Type of course:	compulsory
Entry requirements:	Mathematical Analysis, Linear Algebra with Analytic Geometry, Engineering Physics
Language of instruction:	Polish
Director of studies:	dr hab. inż. Radosław Kłosiński
Name of lecturer:	dr hab. inż. Radosław Kłosiński, academics from the Institute of Electrical Metrology

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					5
Lecture	30	2	I	grade	
Class	15	1		grade	
Laboratory	15	1		grade	
Part-time studies					
Lecture	18	2	I	grade	
Class	9	1		grade	
Laboratory	9	1		grade	

COURSE CONTENTS:

Basic concepts. Electric charge, current, potential, voltage, electric circuit, resistance, induction coil, capacitor, independent voltage source and current source, real source, series and parallel connection.

Basic electrical circuit laws. Ohm's law, Kirchhoff's laws, Thevenin's and Norton's theorems, superposition theorem, reciprocity principle.

Electrical circuits analysis methods. Node voltage method, loop analysis method, superposition method, equivalent network methods.

Circuits supplied with sinusoidal sources. Phasor technique; phasor impedance; phasor diagrams; active, reactive and apparent power; resonance, magnetically coupled circuits.

Three-phase networks.

LEARNING OUTCOMES:

The student knows the basic concepts and principles of the basics of electrical engineering. The student analyzes simple direct current and sinusoidal current circuits. The student can measure voltage, current and active power and outline the basic parameters of the circuit.

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get positive grades in written or oral tests carried out at least once a semester.

Class : to obtain a credit a student has to get positive grades in tests carried out during a semester.

Laboratory: to obtain a credit a student has to get positive grades for all laboratory exercises as scheduled.

RECOMMENDED READING:

1. Blackwell WA. Grigsby LL.: Introductory Network Theory, PWS Publishers, Boston 1985.
2. Bolkowski S.: Electrical engineering, circuit theory. T1, WNT, Warszawa 1982. (in Polish)
3. Cichowska Z., Pasko M.: Theoretical electrical engineering problems. Printed series of course lectures of Silesian Technical University Gliwice 1994 (in Polish)
4. Mikołajuk K., Trzaska Z.: Collection of problems of theoretical electrical engineering. PWN Warszawa 1976. (in Polish)
5. Kłosiński R., Chełchowska L., Chojnacki D., Siwczyńska Z., Rożnowski E, Collection of laboratory exercises instructions, Zielona Góra 1988 – 2004. (not published, in Polish)

OPTIONAL READING:

1. Kurdziel R.: Basics of electrical engineering, WNT, Warszawa, 1973. (in Polish)
2. Bolkowski S., Brociek W., Rawa H.: The electrical circuits theory, tasks, WNT, Warszawa, 2006. (in Polish)

REMARKS:

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ELECTRONICS PRINCIPLES

Course code: 06.5-WE-AIR-PEL-PK24_S1S
Type of course: compulsory
Entry requirements: Electrical Engineering Principles
Language of instruction: Polish/English
Director of studies: Prof. Andrzej Olencki
Name of lecturer: Prof. Andrzej Olencki
academics from the Institute of Computer Engineering and Electronics

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					6
Lecture	30	2	II	exam	
Laboratory	30	2		grade	
Part-time studies					
Lecture	18	2	II	exam	
Laboratory	18	2		grade	

COURSE CONTENTS:

Electronic components. Voltage and current in electronic circuits, principles applied to voltage and current. Resistors, capacitors, inductors, diodes, optoelectronic components, transistors – absolute maximum ratings and electrical characteristics.

Applications of electronic components. Voltage dividers and filters. State signalization of automatic circuits with the application of optoelectronic components. Transistor amplifiers for controlling output automatic components.

Operational amplifiers. General purpose Op Amps and their applications. Op Amps specifications. Basic circuits with Op Amps. Op Amp applications in control engineering: summing and differential amplifiers, PI, PD and PID controllers.

Specialized integrated circuits. Voltage regulators, reference voltage sources, electronic switches and multiplexers, multipliers.

Digital to analogue converters. Types, structures, specifications, applications.

Analogue to digital converters. Types, structures, specifications, applications.

LEARNING OUTCOMES:

Skills and competences in: applying electronic components and integrated circuits to design analogue and mixed (analogue/digital) electronic circuits; understanding, analysis and design of simple electronic circuits for the needs of control engineering.

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get positive grades in all written or oral tests carried out at least once a semester.

Laboratory: to obtain a credit a student has to get positive grades for all the tasks designed in the laboratory syllabus.

RECOMMENDED READING:

1. Paul Horowitz, Winfield Hill: *The Art of Electronics*, Cambridge University Press, New York, USA, 1993

OPTIONAL READING:

1. Walter G. Jung (Editor): *OP Amp Applications*, Analog Devices, USA, 2002
2. Data sheets of electronic components and integrated circuits

REMARKS:

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METROLOGY

Course code: 06.9-WE-AIR-M-PK25_S1S

Type of course: compulsory

Entry requirements: Mathematical Analysis, Electrical Engineering Principles

Language of instruction: Polish

Director of studies: Prof. Ryszard Rybski

Name of lecturer: Prof. Ryszard Rybski

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					6
Lecture	15	1	III	grade	
Laboratory	30	2		grade	
Part-time studies					
Lecture	9	1	III	grade	
Laboratory	18	2		grade	

COURSE CONTENTS:

Basic concepts in metrology. Definition of measurement. Measurement scales and measurement units. Measurement methods and their accuracy. Errors, type A and type B measurement uncertainties, corrections, measurement results. Selected quantity standards. General information on mathematical modelling of objects and phenomena.
Measurements of selected electric quantities. Quantities characterizing electric signals. Static and dynamic properties of measuring instruments. Measuring voltages and currents. Methods and systems for measuring resistance and impedance. Measurements of frequency, period, time and phase shift angle. Power measurements. Electric signal recording.
Introduction to measurement systems. Measurement system definition. Classification of measurement systems. Configuring measurement systems. Interfaces. Examples of measurement system implementations.

LEARNING OUTCOMES:

Skills and competences in: application of units of measurement; patterns of basic measurable units; drawing up measurement results; evaluation of errors and measurement uncertainty; methods and devices for measuring selected electrical quantities; general knowledge of measurement systems.

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get positive grades in a written or oral test carried out at least once a semester.

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Laboratory: to obtain a credit a student has to get positive grades for all the tasks designed in the laboratory syllabus.

RECOMMENDED READING:

1. Tumanski S.: *Principles of electrical measurement.* Taylor & Francis, 2006
2. Bhargawa S.C: *Electrical measuring instruments and measurements*. CRC Press, 2012
3. Vetelino J., Reghu A.: *Introduction to sensors*. CRC Press, 2010

OPTIONAL READING:

1. Skubis T.: *Fundamentals of measurement results metrological interpretation.* Published by Silesian University of Technology, Gliwice, 2004 (in Polish)

REMARKS:

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FOUNDATIONS OF DIGITAL AND MICROPROCESSOR ENGINEERING

Course code: 06.5-WE-AIR-PTCM-PK26_S1S

Type of course: compulsory

Entry requirements: Principles of Discrete Systems, Programming with Basics of 3 , Electronics Principles, Computer System Architecture

Language of instruction: Polish

Director of studies: dr inż. Krzysztof Sozański, dr inż. Robert Dąbrowski

Name of lecturer: dr inż. Krzysztof Sozański, dr inż. Robert Dąbrowski

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					5
Lecture	30	2	III	Grade	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	18	2	III	Grade	
Laboratory	18	2		Grade	

COURSE CONTENTS:

Fundamentals of digital technology. Basic switching gates – technical specifications. Classes of integrated circuits. Integration scale. Numerical systems and codes. Boolean algebra. Logic function. Full function systems. Methods of logic function representation. Representation methods of logic function.

Combinational logic circuits. Analysis and synthesis of combinational logic circuits. Minimization of logic function. Hazard in combinational logic circuits.

Basic synchronous and asynchronous flip-flops. Sequential systems (Mealy and Moore machines). Analysis and synthesis of synchronous and asynchronous circuits. Characteristics of synchronous circuits and comparison with asynchronous circuits.

Digital functional elements in MSI technique. Counters, registers, shift registers. Rules for designing synchronous and asynchronous counters. Designing combinational logic circuits with the application of : multiplexers, decoders, NAND gates.

Data formats used in fixed point and floating point processors. Fixed point and floating point arithmetic.

Arithmetic systems. Summation, subtraction and comparation of binary numbers. Medium-scale integration (MSI) circuits.

Memory: ROM, RAM, EEPROM, FLASH. PLD, CPLD and FPGA systems. Designing digital systems with the application of PLD and CPLD systems.

Microprocessors. Definitions, basic concepts and classification of microprocessors. Functional elements of microcomputer and their cooperation. Microprocessor architectures, the role of their functional elements, instruction cycle.

Programming techniques, instruction set of microprocessors.

Data exchange in microprocessor system. Organization and synchronization of data exchange among microprocessor system elements. Memory and I/O addressing modes.

Data exchange between microprocessor system and external environment. Methods and conditions of servicing the elements of microprocessor system external environment. Data exchange among microprocessor systems. Methods for data exchange: with and without confirmation, synchronous and asynchronous, series and parallel. Advantages and drawbacks of particular methods, range of applications.

Single chip-microcomputers. Characteristics of resources, application rules. Means supporting software and launch of microprocessor systems.

History, trends and comparison of digital signal processors. Basic features of digital signal processors. Differences between a digital signal processor, microcontroller and microprocessor. Signal processor architectures: hardware multiplier, Harvard architecture, multibus architecture, stream conversion, delayed jumps, parallel instructions, long accumulator, shifting system, circular buffer. Memory addressing modes: direct, indirect, immediate, circular, bit reversion. Direct access systems to DMA. Multiprocessor systems.

LEARNING OUTCOMES:

Basic knowledge of: designing basic sequential and combinational circuits; calculating the representation of integers and real numbers as well as performing basic arithmetic operations on the representations; writing basic programmes on the assembler level with the application of conditional statements, loops, operations on integers and real numbers, tables; designing and programming microprocessor systems and circuits..

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Project – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester

RECOMMENDED READING:

1. Martin K., *Digital Integrated Circuit Design (Oxford Series in Electrical and Computer Engineering)*, Oxford University Press, 1999.
2. Brown S., Vranesic Z., *Fundamentals of Digital Logic with VHDL Design*, Mc Graw Hill, 2009.
3. Holdsworth B., Woods C., *Digital Logic Design*, Newnes, 2002.
4. Stallings W., *Computer Organization and Architecture*, Prentice Hall Inc., 1996.
5. Baer J., *Microprocessor Architecture: From Simple Pipelines to Chip Multiprocessors*, Cambridge University Press, 2009.
6. McFarland G., *Microprocessor Design (Professional Engineering)*, McGraw-Hill Professional, 2006.
7. Chassaing R., Reay D., *Digital signal processing and applications with the C6713 and C6416 DSK*, A John Wiley & Sons, Inc., 2008.

OPTIONAL READING:

1. Chassaing R., *Digital Signal Processing with C and the TMS320C30*, John Wiley & Sons, 1992.

REMARKS:

SIGNALS AND DYNAMIC SYSTEMS

Course code: 06.0-WE-AiR-SSD-PK_S1S

Type of course: compulsory

Entry requirements: Mathematical Analysis, Linear Algebra with Analytic Geometry

Language of instruction: English

Director of studies: Prof. Krzysztof Patan

Name of lecturer: Prof. Krzysztof Patan

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					6
Lecture	30	2	III	exam	
Laboratory	30	2		grade	
Part-time studies					
Lecture	18	2	III	exam	
Laboratory	18	2		grade	

COURSE CONTENTS:

Signals. Signal representation. Signal types: step function, binary pseudo-random sequence, auto-regressive sequence, moving average, sum of sinusoids. Persistently exciting signals. Practical aspects of selecting input signal.
Fourier transform. Fourier series and Fourier transform. Spectral analysis. Fast Fourier Transform (FFT).
Laplace transform. Linear differential equations. Laplace transform and its properties. Solving linear differential equations with the application of Laplace transform. Inverse Laplace transform. Transfer function. Basic operations on transfer functions.
Z transform. Linear difference equations. Properties of the Z transform. Z transform of the step function and exponential function. Application of the Z transform to solve linear difference equations. Determining the original of a given Z transform.
Introduction of basic concepts. Dynamic system, system input, system output, internal state, control.
Fundamental properties of systems. Causality, time-invariant systems, systems with a memory, linear systems, stability.
Stability of dynamic systems. Definitions of stability. Linear continuous systems stability criteria: Hurwitz criterion, Routh criterion, Nyquist criterion. Discrete systems stability criteria. Transformation of the left half complex plane into unit circle.
Spectral transfer function. System representation from the form of spectral transfer function. Frequency characteristics: amplitude-phase characteristics, amplitude characteristics and phase characteristics, transient responses: step response and impulse response. Relationship between transient responses and spectral transfer function. Integral operators.
Characteristic of selected dynamic elements. Proportional element, inertial element of the first and second order, integrating element, differential element, oscillating element and delay element.

LEARNING OUTCOMES:

Skills and competences in: signal analysis, Fourier transform, spectral analysis of signals, Laplace transform and Z transform, solving linear differential equations and difference equations, application of stability criteria for continuous and discrete linear systems. Application of observability and controllability criteria.

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get a positive grade in a written and oral test.

Laboratory: to obtain a credit a student has to get positive grades for all the tasks designed in the laboratory syllabus.

RECOMMENDED READING:

1. Oppenheim, Alan V., and A. S. Willsky. *Signals and Systems*. Prentice Hall, 1982.
2. Wong, Y. Yang et. al.. *Signals and Systems with MATLAB*. Springer, 2009.

OPTIONAL READING:

1. Wojciechowski J.: *Sygnały i systemy*, WKŁ, Warszawa, 2008.
2. Patan K.: *Podstawy sygnałów i systemów dynamicznych dla automatyków*, PWSZ, Głogów, 2011.

REMARKS:

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CONTROL ENGINEERING

Course code: 06.0-WE-AIR-TRA-PK28_S1S

Type of course: compulsory

Entry requirements: Mathematical analysis, Mathematical foundations of engineering, Modeling and simulation. Signals and dynamic systems.

Language of instruction: English

Director of studies: Dr. Wojciech Paszke

Name of lecturer: Dr. Wojciech Paszke

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					6
Lecture	30	2	IV	Exam	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	18	2	IV	Exam	
Class					
Laboratory	18	2		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Control of continuous systems: Feedback control: performance indexes, disturbance Rejection and sensitivity, steady-state error, response of closed-loop system.

Introduction to modeling of simple electrical and mechanical systems in time frequency domains. State-space representation. Converting a Transfer Function to State Space and vice versa.

Block Diagrams of feedback systems. Signal-flow graphs. Mason's rule. Signal-flow graphs of state equations.

Time response. Poles, zeros, and system response. Analysis of first order systems. Basic performance indexes. The second order system. System response with additional poles. System response with zeros. Time domain solution of state equations.

Root locus method: Root locus of basic feedback systems. Guidelines for sketching a root locus, controller parameters selection based on a root locus. Controller synthesis with dynamic compensation method (lead and lag compensation), parameters selection for lead and lag compensators. Application of the root locus method for nonlinear systems and systems with delays.

Frequency response method: Frequency response: mathematical foundations, determination of bandwidth. Bode plot techniques: drawing plots for systems with real and complex poles, non-minimal phase systems. Steady-state error. The Nyquist stability criterion: Nyquist plots, applications of the Nyquist stability criterion for controller design, stability margins (phase and gain margins). Relation between closed-loop transient and closed-loop frequency responses. Relation between closed- and open-loop frequency responses. Relation between closed-loop transient and open-loop frequency responses. Steady-state error characteristics from frequency response.

Designing Lead and Lag Compensators. Transient Response via Gain Adjustment. Lag and Lead Compensators. Lead-lag compensator design using either root locus or frequency response

Classical Three-term (PID) controller: Basic features, PID controller tuning with analytical and Ziegler-Nichols methods. Robustness analysis: disturbances and uncertainty. Digital implementation of continuous controllers.

LEARNING OUTCOMES:

Skills and competencies needed to model, analyze and design of linear dynamical systems with time and frequency domain methods.

ASSESSMENT CRITERIA:

Lecture – obtaining a positive grade in written or oral exam.

Laboratory – the main condition to get a pass is scoring sufficient marks for all laboratory exercises.

RECOMMENDED READING:

1. Nise N.S.: *Control Systems Engineering*, 6th Edition International Student Version, John Wiley & Sons, Inc. , 2011.
2. Golnaraghi F., Kuo B.: *Automatic Control Systems*, 9th Edition, John Wiley & Sons, Inc., 2010.
3. Franklin G.E, Powell J.D. Emami-Naeini A.: *Feedback Control of Dynamics Systems.* Addison-Wesley, Upper Saddle River, New Jersey, 2002
4. Dorf, J.C., Bishop R.: *Modern Control Systems*, Prentice-Hall, 2002

OPTIONAL READING:

1. K.J. Åström, R.M. Murray, *Feedback Systems: An Introduction for Scientists and Engineers*, Princeton University Press, Princeton, 2009.

REMARKS:

FUNDAMENTALS OF ROBOTICS

Course code: 06.0-WE-AIR-PR-PK29_S1S

Type of course: compulsory

Entry requirements: Modeling and simulation. Signals and dynamic systems. Control engineering.

Language of instruction: English

Director of studies: Dr. Maciej Patan

Name of lecturer: Dr. Maciej Patan

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					5
Lecture	30	2	V	Exam	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	18	2	V	Exam	
Class					
Laboratory	18	2		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Introduction. Historical outline. Overview of robotic mechanical systems. Tasks performed by robots. Categories of manipulators and robots. Basic components of industrial robots. Grippers. A robot as part of a control system. Structures of manipulators and robots. Linear transformations. Rigid-body rotations. Coordinate transformations and homogeneous coordinates. Degrees of freedom. . *Kinematics.* Kinematic relationships of a manipulator. Link description. Link connections. Forward kinematics. Denavit-Hartenberg parameters. Inverse kinematics. Jacobians.

Dynamics. Joint-space dynamics. Euler-Lagrange equations. Equations of motion. Newton-Euler formalism. Dynamics of a rigid manipulator. Simulation of dynamics.

Trajectory generation. Trajectory planning in configuration space. Cartesian planning. Geometrical problems. Real-time trajectory generation. Trajectory planning using a dynamic model. Collision-free trajectory planning.

Robotic drives. Hydraulic drives. Pneumatic drives. Electric drives.

Robotic sensors. Processing information from sensors. Computer vision. Stereo-based reconstruction.

Applications of robots in industry. Welding applications. Spray painting applications. Assembly operations. Palletizing and material handling. Dispensing operations. Laboratory applications. Work cells.

Wheeled mobile robots. Forward and inverse kinematics of mobile robots. Perception: sensors, representation of uncertainty, feature extraction. Self-localization.

Other applications of robots. Humanoids. Entertainment robots. Medical robots. Exosceletons. Military and police robots.

LEARNING OUTCOMES:

Basic knowledge of modeling, design, planning, and control of robot systems; engineering skills in constructing simple robots from standard components and implementing elementary software for robot control.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the main condition to get a pass are sufficient marks for all laboratory exercices.

RECOMMENDED READING:

1. Spong M. V., Hutchinson S., Vidyasagar M..: *Robot Modeling and Control*, Wiley, Hoboken, NJ, 2006
2. Craig J.J.: *Introduction to Robotics. Mechanics and Control, 3rd Edn.*, Prentice Hall, Englewood Cliffs, NJ, 2004
3. Corke P.: Robotics, Vision and Control, Springer, 2011

OPTIONAL READING:

REMARKS:

CONTINUOUS PROCESS CONTROL

Course code:	06.0-WE-AIR-SPC-PK30_S1S
Type of course:	compulsory
Entry requirements:	Control Engineering , Signals and Dynamic Systems, , Modelling and Simulation, Linear Algebra with Analytic Geometry
Language of instruction:	English
Director of studies:	Prof. Marcin Witczak
Name of lecturer:	academics from the Institute of Control and Computation Engineering

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	30	2	V	exam	
Laboratory	30	2		grade	
Part-time studies					
Lecture	18	2	V	exam	
Laboratory	18	2		grade	

COURSE CONTENTS:

System analysis. Elementary definitions and properties. System definition. Input-output representation. State-space representation. Elementary variables associated with the system being analysed. General concepts of control. Practical applications.
Continuous-time systems. Properties and computer implementations. Typical realisations of continuous-time systems. Input-output representation.
State-space representation. Computer-based implementation of linear and non-linear systems.
Discrete-time systems. Properties and computer implementations. Typical realisations of discrete-time systems. Input-output representation.
State-space representation. Computer-based implementation of linear and non-linear systems.
Analysis of systems described by state-space equations. Structures of the matrices of linear systems. Stability. Observability. Controllability. Computer-based analysis of the above properties. Practical interpretation of stability, observability and controllability.
Design of control systems with output feedback. Rules for designing control systems described by state-space equations with output feedback. Computer-based design techniques. Practical applications.
Design of control systems described by state-space. Rules for designing control systems described by state-space equations with state-feedback. Computer-based design techniques. Separation principle. Practical applications.
Observers. Luenberger observer. Computer-based design techniques and convergence analysis. Practical implementations.

Non-linear control systems. General rules of designing control systems for non-linear systems. Stability analysis with the Lyapunov method. Linearization and application of control techniques for linear systems.
Predictive control. DMC algorithm with a linear model. MTC algorithm with the state-space model. Computer-based implementations. Practical applications.
Layered structure of control systems. Elementary layers of industrial control systems. Data acquisition, visualisation, actuators, etc. Practical applications.

LEARNING OUTCOMES:

Skills and competences in: theoretical analysis and computer implementation of linear and non-linear dynamic systems, observer design, design and computer implementation of control systems with state-feedback and predictive control, practical applications.

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get a positive grade in a written exam (multiple choice test).

Laboratory: to obtain a credit a student has to get positive grades for all the tasks designed in the laboratory syllabus.

RECOMMENDED READING:

1. Dorf, R. i Bishop, R. (2011). *Modern Control Systems*, Prentice Hall, New Jersey.
2. Astrom, S. i Murray, R. (2010). *Feedback systems: An introduction for scientists and engineers*, Princeton University Press, Princeton and Oxford.
3. Nise, N. (2011). *Control Systems Engineering*, Wiley, New Jersey

OPTIONAL READING:-

REMARKS:

ROBOT CONTROL

Course code: 06.0-WE-AIR-SR-PK31_S1S
Type of course: compulsory
Entry requirements: Fundamentals of robotics
Control engineering
Language of instruction: English
Director of studies: Dr. Maciej Patan
Name of lecturer: Dr. Maciej Patan, Dr. Wojciech Paszke

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	15	1	VI	Grade	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project	15	1		Grade	
Part-time studies					
Lecture	9	1	VI	Grade	
Class					
Laboratory	18	2		Grade	
Seminar					
Workshop					
Project	9	1		Grade	

COURSE CONTENTS:

Robot manipulator as a control plant. Point to point control. PD and PID controllers. Observers. Trajectory interpolation. Robot control with Lead feedback and computed moment methods. Multidimensional control.

Robot force control. Natural and artificial constraints. Stiffness and susceptibility. Inverse dynamics in the problem space. Impedance control. Hybrid position/force control.

Advanced control. Feedback linearization. Sliding mode control. Adaptive control.

Programming of robot operation. Programming languages for robotics. Programming structures, robot programming through learning; Task-level programming languages; Requirements for programming languages.

Navigation of autonomic vehicle. Foundations of environment recognition methods. Adaptive identification of mobile robot models. Follower type motion control algorithm. State observers for mobile wheel robots. Prototyping of analyzed systems.

LEARNING OUTCOMES:

Using a wide variety of methods, also those based on state observations; for control of robot manipulators and mobile robots; knowledge of forward and inverse kinematics; trajectory planning and robots programming; knowledge of basic environments recognition methods and navigation.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the main condition to get a pass is scoring sufficient marks for all laboratory exercises.

Project - the main condition to get a pass is positive grade for prepared project.

RECOMMENDED READING:

1. Siegwart R., Nourbakhsh I.R..: *Introduction to Autonomous Mobile Robots*. Addison-Wesley, Upper Saddle River, New Jersey, 2002
2. Asada, H., and J. J. Slotine. *Robot Analysis and Control*. Wiley, New York, 1986.
3. Spong M. W., Vidyasagar M.: *Dynamics and robot control*, Wiley, NJ, 2006
4. Sciavicco L. , Siciliano B.*: Modelling and Control of Robot Manipulators,* McGraw Hill, New York, 1999
5. Corke P.: Robotics, Vision and Control, Springer, 2011

OPTIONAL READING:

REMARKS:

CONTROL OF ELECTRICAL DRIVES

Course code: 06.2-WE-AIR-ANE-PK32_S1S

Type of course: compulsory

Entry requirements: Engineering physics, Electrical engineering principles, Electronics principles, Control engineering

Language of instruction: Polish

Director of studies: D.Sc. Robert Smoleński

Name of lecturer: Prof. Grzegorz Benysek, Dr Jacek Rusiński, Dr Robert Smoleński, Dr Paweł Szcześniak, M.Sc. Piotr Leżyński

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	30	2	VI	Grade	
Class					
Laboratory	15	1		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	18	2	VI	Grade	
Class					
Laboratory	9	1		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Electric motors. Basis of work of electric motors. Servomotors used in robots and robot systems: permanent magnet DC motors (conventional and disc), permanent magnet and reluctance synchronous motors, step motors and induction motors.

Electric drives. Drive system and its parts. Classification of electric drives. Dynamics of electric drives. Dynamic equations of drive systems. Motion equation of drives. Proprieties of second and higher order systems. Modeling of steady and dynamic states of drives.

Power converter drives. Two- and four-quadrant asynchronous drives. DC converter drives, permanent magnet and reluctance converter drives. Brushless DC motors.

LEARNING OUTCOMES:

Skills and competences in: understanding electromechanical energy conversion; basic characteristics of electric machines, selection of drives according to mechanical requirements of driven machine; selection of parameters of converter drives.

ASSESSMENT CRITERIA:

Lecture – in order to get a credit it is necessary to pass all of the required tests (oral or written)

Laboratory - in order to get a credit it is necessary to earn positive grades for all laboratory works defined by tutor

RECOMMENDED READING:

1. Kaźmierkowski M. P., Tunia H.: Automatic Control of Converter-Fed Drives, Warsaw - Amsterdam - New York - Tokyo: PWN-ELSEVIER SCIENCE PUBLISHERS, 1994.
2. Kaźmierkowski M. P., Blaabjerg F., Krishnan R.: Control in Power Electronics, Selected Problems, Elsevier 2002.
3. Boldea I., Nasar S.A, Electric Drives, CRC Press, 1999.
4. Kaźmierkowski M. P. and Orłowska-Kowalska T.: Neural Network estimation and neuro-fuzzy control in converter-fed induction motor drives, Chapter in Soft Computing in Industrial Electronics, Springer-Verlag, Heidelberg, 2002.
5. Leonhard W.: Control of Electrical Drives, Springer, Berlin, New York, 2001.
6. Miller T.J.E.: Brushless Permanent-Magnet and Reluctance Motor Drives, Oxford University Press, Oxford, England, 1989.
7. Sen P.C.: Principles of Electrical Machines and Power Electronics, John Willey and Sons, Inc., New York, USA. 1997.

OPTIONAL READING:

REMARKS:

REAL-TIME SYSTEMS

Course code: 11.3-WE-AIR-SCR-PK33_S1S
Type of course: Compulsory
Entry requirements: -
Language of instruction: Polish
Director of studies: Dr. Robert Szulim
Name of lecturer: Dr. Robert Szulim

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					5
Lecture	30	2	VI	exam	
Class					
Laboratory	30	2		grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	18	2	VI	exam	
Class					
Laboratory	18	2		grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Real-time systems fundamentals: Real-time system definition. Features and basic properties of real-time systems. RT systems architectures. Universal model of RT system.

Real-time systems. RT system classification. Ideas of RT operating systems construction. POSIX norm. Examples of RT systems: QNX, RTLinux, Windows Embedded.

Inter-process communication: Sending and receiving operation. Creating and killing of processes. Creating of child processes. Messages queues. Semaphores. Shared memory. Pipelines. FIFO queue. Deposits. Process synchronization. Timing dependences. File locking and locking files. BSD sockets. Signals. Concurrency and concurrency control. Locks. Mutual exclusions .

Real-time executing module: Process and resource managing. Process scheduling module.

Real-time systems in embedded systems: Reference architecture. Security. Embedded system initialization. Loading RTOS picture. Testing of embedded system based on RTOS. Designing of embedded systems based on real-time systems. Examples of RTOS embedded systems. Software tools and languages. User interface.

Cooperation of real-time systems with other systems and devices. Using serial and network interfaces to exchange data. Integration of real-time systems with databases and World Wide Web systems.

LEARNING OUTCOMES:

Abilities and competence: real-time embedded system designing, using various software techniques to prepare real-time software solutions.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the condition of passing is obtaining positive grades from all laboratory subjects according to the program of the laboratory.

Project - the condition of passing is obtaining positive grades from all project tasks.

RECOMMENDED READING:

1. Chang A.M.K.: Real-time systems. Scheduling, Analysis and Verification. Wiley&Sons, 2005.
2. Li Q.: Real-time Concepts for Embedded Systems. CMP Books, 2006.
3. Liu W.S.:Real-time systems. Wiley&Sons, 2005

OPTIONAL READING:

1. Wei L., Matthews C., Parziale L., Rosselot N., Davis C., Forrester J., Britt D., *TCP/IP Tutorial and Technical Overview*, An IBM Redbooks publication, 2006
2. Ullman Jeffrey D., Widom Jennifer, *A First Course in Database Systems*, Pearson Prentice Hall, 2008
3. Carver R., Tai K.: Modern multithreading, Wiley Publications, 2006

REMARKS:

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OBJECT-ORIENTED PROGRAMMING

Course code: 11.3-WE-AIR-PO-PD35_S1S
Type of course: compulsory
Entry requirements: Programming with Basics of Algorithmic
Language of instruction: Polish
Director of studies: Dr. Paweł Majdzik
Name of lecturer: Dr. Paweł Majdzik

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	15	1	II	Grade	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	9	1	II	Grade	
Laboratory	18	2		Grade	

COURSE CONTENTS:

Introduction to object programming. Concept of abstract data typing. Class definition. Encapsulation – declaration and definition of class member methods. Passing parameters to member functions: via value and via reference. Private and public class members. Function overloading. Constructors: default and copy constructors. Constructor initialization list. Synthesized constructors. Destructors. Operator overloading. Friendly functions. Inline functions. User defined conversions: converting function, converting constructor.

Inheritance. Inheritance rules. Protected members. Multiple and multi-base inheritance. Problem of variable names in multi-base inheritance.

Polymorphism. Virtual functions. Pure virtual functions. Early and late binding. Time and memory costs connected with application of polymorphism.

Abstract classes. Defining and examples of abstract classes application in object-oriented programs.

Virtual destructors. Function templates. Definition of stencil functions. Specialized functions. Phases of function adjustment. Class templates. Definition of class templates. Class templates versus micro- definitions. Static components in class pattern. Inheritance of class templates. Application examples of class templates. Specialized classes. Exception handling. Use of templates from STL library – container templates, iterators, associative containers (maps, sets).

LEARNING OUTCOMES:

Skills and competences in : knowledge of C++ language: encapsulation, inheritance, polymorphism, function and class templates; design and implementation of object and object-oriented programs; application of object programs in programs from STL (Standard Template Library).

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get a positive grade in a written exam.

Laboratory: to obtain a credit a student has to get positive grades for all the tasks designed in the laboratory syllabus.

RECOMMENDED READING:

1. Eckel B.: *Thinking in C++*, Prentice Hall, US Ed edition, 2002.
2. Kerighan B., Ritchie D.: *Programowanie w języku C*, WNT, Warszawa, 2000.

3. Stroustrup B.: The C++ Programming Language, Addison – Wesley, 2004

OPTIONAL READING:

[1] 1. Lippman S.B.: Inside the C++ Object Model, Addison – Wesley, 1996

REMARKS:

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MODELLING AND SIMULATION

Course code:	11.9-WE-AIR-MS-PD36_S1S
Type of course:	compulsory
Entry requirements:	Mathematical Analysis, Linear Algebra with Analytic Geometry
Language of instruction:	Polish
Director of studies:	prof. dr hab. inż. Dariusz Uciński
Name of lecturer:	prof. dr hab. inż. Dariusz Uciński, academics from the Institute of Control and Computation Engineering

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					5
Lecture	30	2	II	exam	
Laboratory	30	2		grade	
Part-time studies					
Lecture	18	2	II	exam	
Laboratory	18	2		grade	

COURSE CONTENTS:

Introduction to Maple V and Maxima. Elements of the language. Assignment. Basic types: sequences, sets, lists, tables, arrays and strings. Calling procedures. Using apostrophes. Internal data representation. Solving linear and nonlinear equations. Functions for linear algebra and mathematical analysis. Simplification of expressions: simplify, factor, expand, convert, normal, combine, map i assume. 2D and 3D graphics. Programming foundations. Applications in mathematical analysis, linear algebra, statistics and selected engineering problems.
Mathematical models of dynamic systems. Models, modelling and simulation. Classification of modelling methods. Goals and stages of modelling. Basic physical laws. Exemplary models of mechanical, electrical, economical and control systems.
Ordinary differential equations. Definitions, classification. Examples of geometric and physical problems leading to differential equations. Geometrical interpretation. Direction field. Integrals of ordinary differential equations. Existence and uniqueness of solutions. First-order equations in normal form. Equations with separated variables. Homogeneous equations. Linear equations. Bernoulli and Riccati equations. Complete differential equations. Trajectories. N-th order linear differential equations. General integrals of linear equations. Fundamental matrix and its properties. Second-order equations with variable coefficients. Systems of nonlinear ordinary differential equations.
Numerical methods of solving ordinary differentia equations. One-step methods: Euler method, trapezoid method (Crank-Nicolson), Heun method. Explicit and implicit schemes. Multistep methods: Adams methods, backward difference methods. Predictor-corrector methods. Runge-Kutta methods. Adaptive step size selection. Systems of ordinary differential equations. Stiff problems.

Continuous linear dynamic systems. Descriptions: ordinary differential equations, transfer functions. Determining responses to any inputs. Matrix transfer functions. Examples of fundamental elements. State equations of linear systems.
Discrete linear dynamic systems. Engineering examples. Difference equations. Transfer functions of discrete systems. State equations.
Matlab-Simulink and Scilab-Scicos environments. Characteristics and applications. Operations on vectors and matrices. Logical expressions. Basic mathematical functions. 2D and 3D graphics. Animation. Low-level graphical functions. Iteration instructions. Scripts and functions. Elements of programming. Debugger. Code efficiency. Recursion. Vectorization of algorithms. Operating on strings. Nonstandard data structures: sparse matrices, structures, cell arrays, multidimensional arrays. Building graphical user interfaces. Operations on files. Calling MATLAB from C programs. Selected toolboxes. Building models of continuous and discrete processes. Simulink: blocks, S-functions.
Building mathematical models based on the principle of least action. Models of mechanical systems. Models of electrical systems. Models of electromechanical systems. Models of gases and liquids. Models of thermal systems. Models of chemical and biochemical processes. Model linearization. Implementation in MATLAB/Simulink.

LEARNING OUTCOMES:

Skills and competences in : application of mathematical description in continuous and discrete dynamic processes. Working knowledge of simulation software and computer algebra systems (Matlab/Simulink, Scilab/Scicos, Maple V/Maxima).

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get positive grades in all written or oral tests carried out at least once a semester .

Laboratory: to obtain a credit a student has to get positive grades for all the tasks designed in the laboratory syllabus.

RECOMMENDED READING:

1. Edwards D., Hamson M.: *Guide to mathematical modelling*, Industrial Press, New York, 2007.
2. Hunt B.R., Lipsman R.L., Rosenberg J.M.: *A guide to Matlab for beginners and experienced users*, Cambridge University Press, Cambridge, 2001.
3. Lee H.J., Schiesser W.E.: *Ordinary and partial differential equation routines in C, C++, Fortran, Java, Maple and Matlab*, Chapman & Hall/CRC, Boca Raton, 2004.
3. Karris S.T.: *Introduction to Simulink with engineering applications*, Orchard Publications, 2006

REMARKS:

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PRINCIPLE OF POWER ELECTRONICS

Course code: 06.5-WE-AIR-PEE-PD37_S1S
Type of course: compulsory
Entry requirements: Engineering physics, Electrical engineering principles, Electronics principles, Metrology
Language of instruction: Polish
Director of studies: Professor Zbigniew Fedyczak
Name of lecturer: Professor Zbigniew Fedyczak

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	15	1	III	Grade	
Class					
Laboratory	15	1		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	9	1	III	Grade	
Class					
Laboratory	9	1		Grade	
Seminar					
Workshop					
Project	9	1		Grade	

COURSE CONTENTS:

Basic power electronics circuits (general description). Power electronics – historical outline. Application area. Types of power electronic converters (PEC), their classification and basic functions.

Basic parameters and conversion quality evaluation of the PEC. Coefficients or factors: efficiency, total harmonics distortion, power, deformations, displacement, non-symmetry at non-sinusoidal current circumstances.

Non-controlled and controlled rectifier (AC/DC converters). Topologies and properties of single-, two- and six-pulsed non-controlled rectifiers. Single- and three-phase thyristor rectifiers with phase control. Influence of the rectifiers on supplying source. Examples of applications.

DC/DC PWM voltage and current stabilizators (DC/DC converters). Topologies and properties of the impulse DC stabilizators types buck, boost and buck-boost with PWM control. Examples of applications.

Single-phase AC choppers (AC/AC converters, $f_1 = f_2$). Solid state relay and thyristor choppers. Phase-angle and integral control. Static characteristics, power factor. Examples of applications.

Inverters (DC/AC converters). Single-phase voltage source inverters. Functioning and properties of the transistorized inverters. The PWM control strategy in the inverters. Operation general description of three-phase voltage source inverter with square-wave modulation and sinus PWM. Examples of applications.

Problems and development trends of the PEC. Intelligent power module, multilevel converters, resonance converters. Future trends.

LEARNING OUTCOMES:

Skills and competence in understanding of basic power electronic semiconductor devices and circuits, knowledge of their properties and application fields.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the main condition to get a pass is scoring sufficient marks for all laboratory exercises.

Project – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

1. Pirog S., *Power electronics*, AGH Publishing House, Cracow, 2006 (in Polish).
2. Mohan N., *Power Electronics: Converters, Application and Design*, John Wiley & Sons, 1998.
3. Trzynadlowski A., *Introduction to modern power electronics*, John Wiley & Sons, 1998.
4. Erickson R., W., Maksimowić D.: *Fundamentals of power electronics.* Kluver Academic Publishers, 1999.

OPTIONAL READING:

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REMARKS:

STATISTICAL METHODS OF DATA ANALYSIS

Course code: 11.2-WE-AIR-MAD-PD38_S1S

Type of course: compulsory

Entry requirements: Mathematical analysis
Mathematical foundations of engineering
Numerical methods

Language of instruction: English

Director of studies: Dr. Maciej Patan, Prof. Dariusz Uciński

Name of lecturer: Dr. Maciej Patan,

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	30	2	III	Grade	
Class	15	1		Grade	
Laboratory					
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	9	1	III	Grade	
Class	9	1		Grade	
Laboratory					
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Measurement uncertainty. Uncertainty transfer. Random and systematic errors. Distributive series. Histogram. Measures of location, variability, asymmetry and concentration. Rejecting data.

Probability. Sample space. Probability definitions: classical, frequency-based and modern. Elementary properties. Conditional probability. Independence. Total probability. Bayes formula.

Discrete and continuous random variables. Discrete random variables. Distributions: binomial, Poisson and geometric. Functions of random variables. Notions of expected value and variance. Joint distributions for many random variables. Independence of random variables. Continuous random variables. Uniform and exponential distributions. Cumulative distribution function. Normal distribution.

Basics of statistical inference. Sample generation schemes. Distributions: chi-square, t-Student and Fisher-Snedecora. Point and interval estimation. Unbiasedness, consistency, effectiveness and sufficiency. Parametric and non-parametric estimation. Confidence intervals for expected value. Limit theorems. Confidence intervals for expected value in population with unknown distribution, variance, standard deviation and probability.

Statistical hypotheses testing. Parametric significance tests for expected value and variance of population structure indicator. Non-parametric significance tests.

Linear and polynomial regression. Analysis of phenomena correlation. Correlation and regression. Least squares method. Inference in correlation and regression analysis. Linear correlation coefficient.

LEARNING OUTCOMES:

Skills and competences in: formulation of uncertainty description, calculation of elementary statistical parameters and probability for events, analysis of an average systems behavior, calculation of a reliability for simple hardware and software systems, application of stochastic processes for analysis of effectiveness of hardware-software systems, providing basic statistical inference.

ASSESSMENT CRITERIA:

Lecture – the passing condition is to obtain positive mark from the final test;
Classes – the passing condition is to obtain positive marks from all tests, which take place at least twice in the semester

RECOMMENDED READING:

1. Liengme B.V.: *Guide to Microsoft Excel 2007 for scientists and engineers*, Elsevier, 2008
2. Bertsekas D., Tsitsiklis J.: *Introduction to probabilisty*, Athena Scientific, 2008
3. Triola M.: *Elementary statistics*, Addison Wesley Longman, 2008
4. Devore J.: *Probability and Statistics for Engineering and Sciences*, Brook/Cole Publishing, 2004
5. Grinstead Ch., Snell J.: *Introduction to Probability*, AMS Bookstore, 1997optional reading:

REMARKS:

DISCRETE PROCESS CONTROL

Course code: 06.0-WE-AIR-SPD-PD39_S1S

Type of course: compulsory

Entry requirements: Principles of Discrete Systems, Computer System Architecture

Language of instruction: Polish

Director of studies: prof. dr hab. inż. Marian Adamski, dr inż. Grzegorz Bazydło

Name of lecturer: dr inż. Grzegorz Andrzejewski, academics from the Institute of Computer Engineering and Electronics

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	15	1	III	exam	
Laboratory	30	2		grade	
Part-time studies					
Lecture	9	1	III	exam	
Laboratory	18	2		grade	

COURSE CONTENTS:

Lecture: formal specification of discrete processes on behavioral level. Sequential Function Chart (SFC), statechart diagram, hierarchical Petri net.

Modular behavioral specification of logic control programs with the application of hierarchical SFC and Petri net. SFC, relations between SFC and Petri net. Modular design, IP-Cores. The role of the formal specification in programming of industrial PLCs.

UML as a reactive system specification tool. State machine diagram. Activity diagram. Use cases. UML role in documenting and synthesis of programs for digital embedded microsystems.

Formal verification. Application of Petri net theory. SAT methods, usage of experts systems.

Architectures of logic controllers: microcontroller as logic controller, digital SoC (System on a Chip) microsystems. Industrial PLCs (Programmable Logic Controllers). Embedded, reconfigurable logic controller (RLC).

Software or hardware realization of logic controllers. Programming PLCs according to IEC1131 standard, on the basis of behavioral specification. Structure synthesis of embedded controllers using formal methods on the basis of behavioral specification. Role of SystemC, VHDL and Verilog in system synthesis.

Laboratory: specification and modeling of binary control algorithms on the system level with the application of UML and other tools to effective computer aided design of digital microsystems.

LEARNING OUTCOMES:

Skills and competences: formal specification and efficient program design for embedded microsystems intended for discrete process control.

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get a positive grade in an exam.

Laboratory: to obtain a credit a student has to get positive grades for all the tasks designed in the laboratory syllabus.

RECOMMENDED READING:

1. Węgrzyn A., Chodań M.: Formal analysis of SFC nets, Proceedings of the Seventh International Conference Advanced Computer Systems - ACS 2000, Wydaw. i Drukarnia Wydziału Informatyki Politechniki Szczecińskiej, Szczecin, 2000.

2. Żurawski R.(Ed.): Embedded Systems Handbook, CRC, Boca Raton, 2006.

3. Adamski M., Karatkevich A., Węgrzyn M.: Design of Embedded Control Systems, Springer (USA), New York, 2005.

4. David D., Alla H.: Petri Nets & Grafcet. Tools for modeling discrete event systems, Prentice Hall, New York, 1992.

5. Gajski D.D, Vahid F., Narayan S., Grong J.: Specification and Design of Embedded Systems, Prentice Hall, Englewood Cliffs, New Jersey, 1994.

6. Jerraya A., Mernet J. (Ed): System-Level Synthesis, Kluwer, Dordecht, 1999.

7. Booch G., Rumbaugh, J., Jacobson I.: The Unified Modeling Language User Guide (2nd Edition), Addison-Wesley Professional, 2005.

8. Yakovlev, Gomes L., L. Lavagno (Ed.): Hardware Design and Petri Nets, Kluwers Academic Publishers, Boston, 2000

OPTIONAL READING:

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REMARKS:

DIGITAL SIGNAL PROCESSING

Course code: 06.0-WE-AIR-CPS-PD40_S1S
Type of course: compulsory
Entry requirements: Mathematical Analysis, Linear Algebra with Analytic Geometry, Principles of Electronics, Principles of Discrete Systems, Signals and Dynamic Systems
Language of instruction: Polish
Director of studies: dr hab. inż. Ryszard Rybski, dr hab. inż. Radosław Kłosiński
Name of lecturer: dr hab. inż. Radosław Kłosiński, academics from the Institute of Electrical Metrology

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					5
Lecture	15	1	IV	exam	
Laboratory	30	2		grade	
Part-time studies					
Lecture	9	1	IV	exam	
Laboratory	18	2		grade	

COURSE CONTENTS:

Basic notions. Classification of signals. Analogue/digital and digital/analogue conversion. Quantization noise, signal-to-noise ratio.

Spectral analysis of signals. Signal's spectrum. Fourier integral transform and Discrete Time Fourier Transform (DTFT). Discrete and fast Fourier transform.

Description of discrete systems. Impulse response and convolution. Differential equations. Z transform. Transmittance. Frequency characteristics.

Digital filtering basics. Finite and indefinite impulse response systems. Recursive differential equation. Basis of designing of IIR and FIR filters. Digital simulation of continuous time systems.

LEARNING OUTCOMES:

The student knows the basic concepts of digital signal processing and knows the representation of signals and systems in the discrete time and frequency domain. Can perform spectral analysis of digital signals and interpret the results. The student is capable to design by means of programming tools and use linear digital system with a given characteristic. Can create digital models of continuous time systems and realize the simulation.

ASSESSMENT CRITERIA:

Lecture: to obtain a credit the student has to get positive grades in all written or oral tests carried out at least once a semester.

Laboratory: to obtain a credit the student has to get positive grades for all laboratory exercises as scheduled.
Project: to obtain a credit the student has to get positive grades for all exercises as scheduled. (part-time studies)

RECOMMENDED READING:

1. Lyons R.G.: „Understanding Digital Signal Processing”. Addison Wesley Longan, Inc. 2004.
2. Zieliński T.P.: „From theory to digital signal processing”. Dep. EAIiE AGH, Kraków 2002. (in Polish)
3. Mitra S.: Digital Signal Processing: A Computer-Based Approach, Mc-Graw-Hill, 2005.
4. Oppenheim A.V., Scharfer R.W., Buck J.R.: „Discrete-Time Signal Processing”. Prentice Hall 1999.

OPTIONAL READING:

1. Smith S.W.: „The Scientist and Engineer's Guide to Digital Signal Processing”. California Technical Publishing, Sand Diego, California 1999. http://dspguide.com
2. Oppenheim A.V., Willsky A.S., Nawab S.H.: „Signal & Systems”. Prentice Hall 1997.

REMARKS:

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DECISION SUPPORT SYSTEMS

Course code: 11.4-WE-AIR-SWD1-PD41_S1S

Type of course: compulsory

Entry requirements: Linear Algebra and Analytic Geometry, Artificial Intelligence Methods

Language of instruction: Polish

Director of studies: Prof. Andrzej Pieczyński

Name of lecturer: Prof. Andrzej Pieczyński, academics from the Institute of Control and Computation Engineering

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					5
Lecture	15	1	IV	exam	
Laboratory	30	2		grade	
Part-time studies					
Lecture	9	1	IV	exam	
Laboratory	18	2		grade	

COURSE CONTENTS:

Concepts in decision making. Intelligence quotient, decision making process. Tasks of decision making system.

Multicriteria analysis. Decision making in multicriteria environment. Elimination methods. Knowledge acquisition. Knowledge acquisition from the expert. Methods for knowledge extraction from data. Learning systems. Heuristic methods for knowledge extraction.

Fuzzy systems. Linguistic variable. Fuzzy membership functions. Fuzzy inference. Determination of fuzzy system response. Fuzzy models.

Expert systems. Artificial intelligence. Expert systems – types, structure and tasks. Inference methods. Application of fuzzy logic in expert systems.

Synthesis of optimal decision rules. Parametric decision rules. Decisions based on repeated optimization. Multi-variant scenario.

LEARNING OUTCOMES:

Skills and competences in: modelling decision situations; multicriteria analysis; application of optimal and parametric decision rules , and repeated optimization; decision making in uncertain and risky circumstances; multicriteria problem analysis; application of data bases and model bases; extracting and processing knowledge with the application of fuzzy systems; application of expert systems in decision making; handling decision support systems.

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get a positive grade in a written exam .

Laboratory: to obtain a credit a student has to get positive grades for all the tasks designed in the laboratory syllabus.

RECOMMENDED READING:

1. Janakiraman V.S., Sarukesi K.: *Decision support systems,* PHI Learning Pvt. Ltd., 2004
2. Marakas G.M.: *Decision support systems in the 21st century,* Prentice Hall, 2003
3. Power D.J.: *Decision support systems: frequently asked questions*, iUniverse 2005
4. Turban E., Aronson J.E., Liang .T.P: *Decision support systems and intelligent systems,* Pearson/Prentice Hall, 2005
5. Turban E., Sharda R., Dursun D.: *Decision support systems and business intelligence systems,* Prentice Hall, 2010

OPTIONAL READING:

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OPERATING SYSTEMS AND COMPUTER NETWORKS II

Course code: 11.4-WE-AiR-SOS2-PD42_S1S
Type of course: compulsory
Entry requirements: Computer System Architecture
Language of instruction: Polish
Director of studies: Prof. Krzysztof Patan
Name of lecturer: Prof. Krzysztof Patan

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					2
Laboratory	30	2	IV	grade	

COURSE CONTENTS:

Advanced operation of Windows XP/Vista. User account management, resource access management using groups, access rights to files and catalogues; group rules, system register, system log management.

Linux – basic operation rules. Work from console level, basic Linux instructions. Basics of creating shell scripts. Work on X Window system. GUI system configuration.

Work in Windows 2008 Server domain. Creating domain user accounts. Remote access to server.

MAC OS X. User account management, work from console level, system configuration.

LEARNING OUTCOMES:

Skills and competences: configuration of computer and operation system for computer network and local work.

ASSESSMENT CRITERIA:

Laboratory: to obtain a credit a student has to get positive grades for all the tasks designed in the laboratory syllabus.

RECOMMENDED READING:

1.Solomon D.A., Russinovich M.E.: *Microsoft Windows 2000. Od środka*, Helion, Gliwice, 2003.
2.Morimoto R.,Noel M., Droubi O., Żardinier K., Neal N.: *Windows Server 2003. Księga eksperta*, Helion, Gliwice, 2004.
3.Johnson M.K., Troan E.W., *Oprogramowanie użytkowe w systemie LINUX*, WNT, Warszawa, 2000.

OPTIONAL READING:

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REMARKS:

PROGRAMMABLE LOGIC CONTROLLERS

Course code: 06.5-WE-AIR-PSL-PD43_S1S
Type of course: compulsory
Entry requirements: Architecture of computer systems
Language of instruction: Polish/English
Director of studies: dr inż. Grzegorz Andrzejewski, dr inż. Małgorzata Kołopieńczyk
Name of lecturer: dr inż. Grzegorz Andrzejewski, dr inż. Małgorzata Kołopieńczyk

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					5
Lecture	**15**	1	IV	Grade	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	9	1	IV	Grade	
Laboratory	18	2		Grade	

COURSE CONTENTS:

Introduction to PLC technique. PLC Characteristic, construction, operation principle.
PLC market review. PLC parameters and models.
Ladder Diagram programming language. Basic elements, programming rules. Language constructions. Combinational systems design. Sequential, parallel and timing systems design.
IL programming language. Basic elements, programming rules. Language constructions. Combinational systems design. Sequential, parallel and timing systems design.
ST programming language. Basic elements, programming rules. Language constructions. Combinational systems design. Sequential, parallel and timing systems design.
Functional Blocks Diagram language. Basic elements, programming rules. Language constructions. Combinational systems design. Sequential, parallel and timing systems design.
SFC programming language. Basic elements, programming rules. Language constructions. Combinational systems design. Sequential, parallel and timing systems design.
Human Machine Interface device. User interface design. Communication between HMI and control system.
PLC Project documentation.

LEARNING OUTCOMES:

Competences in basic PLC systems design and programming

ASSESSMENT CRITERIA:

Lecture: written test
Laboratory: written test

RECOMMENDED READING:

1. L. A. Bryan, E. A. Bryan: Programmable controllers. Theory and Implementation., Amer Technical Pub, 2003.
2. K. Collins: PLC Programming for Industrial Automation, Exposure Publishing, 2006.
3. S. P. Tubbs: Programmable Logic Controller (PLC) Tutorial, Stephen Philip Tubbs, 2005.

REMARKS:

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ACUTATORS

Course code: 06.0-WE-AIR-EWA-PS44_AP_S1S
Type of course: compulsory
Entry requirements: Mathematical Analysis, Linear Algebra with Analytic Geometry, Engineering Physics, Electrical Engineering Principles, Electronics Principles, Power Electronic Principles, Control Engineering
Language of instruction: Polish
Director of studies: Prof. dr hab. inż. Igor Korotyeyev
Name of lecturer: Prof. dr hab. inż. Igor Korotyeyev, dr inż. Jacek Kaniewski

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	30	2	V	exam	
Laboratory	30	2		grade	
Part-time studies					
Lecture	18	2	V	exam	
Laboratory	18	2		grade	

COURSE CONTENTS:

General characteristics. Functions of actuators in automatic systems. Classification of actuators according to input/output signals and energy media used in acutators.

Electric actuators. Drive systems in automatics. Drive systems fed-by power electronic converters. Acutators in electrothermy. Actuators in control systems of environmental conditions. Examples of applied solutions.

Pneumatic and hydraulic actuators. Control of pneumatic and hydraulic energy flux. Basic elements of pneumatic and hydraulic devices. Examples of applied solutions.

Robot drives. Pneumatic drives. Electrohydraulic drives. Electric drives. Mechanical gears. Rotating gears. Rotation translation gears. Speed reduction gears. Examples of applied solutions.

Gripping devices of robots and their applications. Tasks for gripping devices. Classification and characteristics of gripping devices. Selection of a gripping device type for a given manipulation object class. Construction of mechanical grabs, drive systems of grabs, drive transmission arrangements, performing systems of grabs.

Control systems. General characteristics and examples of control system solutions for electric, pneumatic and hydraulic actuators.

Problems and development trends. Safety issues concerning the use and influence of actuators on the environment. New development trends.

LEARNING OUTCOMES:

Skills and competences in: understanding the operation principles of basic elements and performing devices of automatic control systems, knowledge concerning their proprieties and application areas**.**

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get positive grades in all written tests carried out at least once a semester.

Laboratory: to obtain a credit a student has to get positive grades for all the tasks designed in the subject syllabus.

RECOMMENDED READING:

1. Boldea I., Syed A. Nasar. Linear electric actuators and generators. Cambridge University Press, 1997.
2. Parr E.A., Industrial control handbook. Butterworth Heinemann Ltd. 1995
3. Ganesh S. Hedge.A textbook of industrial robotics. Laxmi Publications, 2006.

OPTIONAL READING:

4. Hering M.: *Podstawy elektrotermii*. Część I i II, Warszawa, WNT 1992, 1998.
5. Praca zbiorowa. *Podstawy robotyki. Teoria i elementy manipulatorów i robotów*, Warszawa, WNT, 1999.
6. Osiecki A.: *Hydrostatyczny napęd maszyn*. Warszawa, WNT, 2004.
7. Praca zbiorowa: *Konstrukcja przyrządów i urządzeń precyzyjnych*. Warszawa, WNT, 2006.

REMARKS:

Laboratory classes should be held in groups limited to 12 students

MEASUREMENT TRANDUCERS

Course code: 06.0-WE-AIR-PP-PS45_AP_S1S

Type of course: compulsory

Entry requirements: Electrical Engineering Principles, Electronics Principles, Metrology, Foundations of Digital and Microprocessor Engineering

Language of instruction: Polish

Director of studies: Prof. Ryszard Rybski

Name of lecturer: Prof. Ryszard Rybski

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	30	2	V	exam	
Laboratory	30	2		grade	
Part-time studies					
Lecture	18	2	V	exam	
Laboratory	18	2		grade	

COURSE CONTENTS:

Introduction. Transducer, sensor. The role of sensors and transducers in automatics and robotics. Sensor and transducers classification. Static and dynamic properties of measurement transducers.

Introduction to analog measurement signals conversion. The basic functional blocks performing linear and nonlinear function for measurement signals converting. The basic functional blocks of analog converters performing linear and nonlinear signal processing functions of the measurement.

Analog-to-digital and digital-to-analog conversion. Characteristics of the main types of A/D and D/A converters. The parameters of A/D and D/A converters. Some examples of applications of A/D and D/A converters.

Introduction to measurements of non-electrical quantities using electrical methods. Classification and basic areas of sensors application. Technologies of sensors production. Smart sensors.

Conditioning circuit of output signals of sensors. General characteristics of parameter change (resistance and reactance) and generational sensors. Conditioning circuits working with parametric and generational sensors.

Conditioning circuits for output signals of transducers. General characteristics of the active (resistance and reactance) and the passive sensors. Conditioning circuits working with active and passive sensors.

Measurements of quantities describing motion. Linear displacement sensors: with parameter change of electric circuits, ultrasonic, optoelectronic. Acceleration and velocity sensors for linear and angular motion. Angular displacement sensors.

Strength and pressure measurements. Strain gauges, piezoelectric and magnetic strength sensors. Membrane pressure sensors.

Temperature measurements. Metal and semiconductor resistive sensors, semiconductor junction sensors, integrated temperature sensors, thermoelectric sensors, fiber optic sensors, touchless temperature measurement.

Selected applications of sensors in robotics. Tactile sensors, wheel position sensors, orientation sensors.

LEARNING OUTCOMES:

The student knows the parameters and methods used to describe and evaluate the static and dynamic properties of transducers

The student can name and describe the basic functional blocks of circuit for analog signal conversion.

He can explain the principle of work of the basic types of analog-to-digital and digital-to-analog converters and measurement transducers of main non-electrical quantities. He can tell - using the examples - the most important areas of the converters application.

He is able to plan and carry out an experiment that allows the experimental determination of transducer conversion characteristics.

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get a positive grade in a written or oral exam.

Laboratory: to obtain a credit a student has to get positive grades for all the tasks designed in the subject syllabus.

RECOMMENDED READING:

1. Tumanski S.: *Principles of electrical measurement.* Taylor & Francis, 2006
2. Bhargawa S.C: *Electrical measuring instruments and measurements*. CRC Press, 2012
3. Vetelino J., Reghu A.: *Introduction to sensors*. CRC Press, 2010
4. Pallas-Areny R., Webster J.G.: *Sensors and signal conditioning*. John Willey& Sons, Inc., 2001
5. Fraden J.: *Handbook of modern sensors*. Springer, 2010

OPTIONAL READING:

1. Horowitz P., Hill W.: *The art electronics.* Cambridge University Press, 1999

REMARKS:

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ELECTROMAGNETIC COMPATIBILITY

Course code: 06.2-WE-AIR-KE-PS46_AP_S1S

Type of course: compulsory

Entry requirements: Electrical Engineering Principles, Electronics Principles, Digital Signal Processing

Language of instruction: Polish

Director of studies: dr hab. inż. Adam Kempski, prof. UZ

Name of lecturer: academics from the Institute of Electrical Engineering

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	30	2	VI	Exam	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project	15	1		Grade	
Part-time studies					
Lecture	18	2	VI	Exam	
Class					
Laboratory	18	2		Grade	
Seminar					
Workshop					
Project	9	1			

COURSE CONTENTS:

Introduction to electromagnetic compatibility (EMC). Basic terms. EMC terminology. Immunity and emissions of electric equipment. Interference sources – intentional and non-intentional.

Electromagnetic fields and coupling mechanisms. Near and far field terms. Conducted and radiated interferences. Basic mechanisms of electromagnetic interferences couplings and propagations: galvanic, by means of near and far fields. Propagation of EMI in transmission lines. Basics of EMI signal analysis.

EMC measurement and investigations. Methods of electromagnetic emission measurements. Immunity measurements. Measurements at the development stage. Compliance and receiving measurements.

Electromagnetic compatibility of automatics systems. Properties of real elements in the interference frequency range. Signal integrity. EMC of control and transmission systems. EMC of acutators. EMC and functional safety of automatics systems.

EMC strategy. EMC analysis and simulations. Techniques of EMI effects reduction – earthing and bonding, shielding, topology and structure of circuits, EMI filters. Development of devices according to EMC requirements. Internal and external EMC. EMC for systems and installations.

EMC standardization. New and Global Approach. EMC Directive. EMC standards. EMC standards classification – generic, basic and product standards. EMC regulations concerning people's protection.. Present state of EMC standardization. Procedures for obtaining CE marking and legal responsibility of manufacturer.

LEARNING OUTCOMES:

Skills and competences in: identifying basic mechanisms of couplings and propagation of electromagnetic interferences, electromagnetic emission and immunity measurement methods; application of EMI mitigation techniques; production of devices according to EMC requirements; knowledge of basic EMC legal requirements.

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get a positive grade in an exam.

Laboratory: to obtain a credit a student has to get positive grades for all the tasks designed in the laboratory syllabus.

Project: to obtain a credit a student has to get positive grades for all project exercises conducted during the semester.

RECOMMENDED READING:

1. Charoy A.: Zakłócenia w urządzeniach elektronicznych, WNT W-wa, 1999.
2. Więckowski T.W.: Badania kompatybilności elektromagnetycznej urządzeń elektrycznych i elektronicznych, Wydawnictwa Politechniki Wrocławskiej, Wrocław, 2001.
3. Machczyński W.: *Wprowadzenie do kompatybilności elektromagnetycznej*, Wydawnictwo Politechniki Poznańskiej, Poznań, 2004.
4. Williams T., Armstrong K.: *EMC for systems and Installations*, Newnes, 2000.
5. Weston D.A.: *Electromagnetic Compatibility*, Principles and Applications. Marcel Dekker Inc., 1991.

OPTIONAL READING:

1. Otto H.W.: *Metody redukcji szumów i zakłóceń w układach elektronicznych*, WNT Warszawa, 1979.
2. Kempski A.: *Elektromagnetyczne zaburzenia przewodzone w układach napędów przekształtnikowych*, Oficyna Wydawnicza Uniwersytetu Zielonogórskiego, Zielona Góra, 2005.
3. Tichanyi L.: *Electromagnetic Compatibility in Power Electronic*, J.K.Eckert & Company, 1995.

SOFTWARE FOR MEASUREMENT AND CONTROL EQUIPMENT

Course code: 06.2-WE-AIR-OAPS-PSW_B48_AP_S1S

Type of course: optional

Entry requirements: Programming with Basics of Algorythmics, Electronics Principles, Foundations of Digital and Microprocessor Engineering

Language of instruction: Polish

Director of studies: dr inż. Janusz Kaczmarek

Name of lecturer: dr inż. Janusz Kaczmarek, academics from the Institute of Electrical Metrology

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	15	1	V	Grade	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	9	1	V	Grade	
Class					
Laboratory	18	2		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Microprocessor-based equipment for measurement and control. Selected elements of a microprocessor technique. Architecture of microprocessor devices for measurement and control.
Introduction to programming embedded systems. Integrated programming environments. Programming languages – assembler and high-level programming languages. Hybrid programming technique. Effective fixed-point arithmetic on fractional numbers. Methods of code optimization. Programming of internal and external peripherals.
Application of real-time operating system (RTOS) to design the software for embedded systems with low resources. Basic terms. Principles and aims of applying RTOS systems. Mechanisms of RTOS kernel. Scalability of RTOS. Examples of RTOS designed for embedded systems. Advantages of applying RTOS in measurement and control equipment.
Implementation of selected measurement and control algorithms. Control procedures for a/c and c/a converters. Programming methods for generating and measuring analog and digital signals. Implementation of loop control in industrial regulators.
Software and hardware debugging methods for embedded systems. Testing software functional properties: program simulators, simulations on the basis of a schematic diagram. Testing software in a target diagram: monitor systems installed in the target, hardware emulators, SoC technique.

LEARNING OUTCOMES:

Skills and competences in: the field of designing and creating software for embedded systems with the emphasis on measurement and control equipment.

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get positive grades in all written or oral tests carried out at least once a semester.

Laboratory: to obtain a credit a student has to get positive grades for all the tasks designed in the laboratory syllabus.

RECOMMENDED READING:

1. Barney G.C.: *Intelligent Instrumentation. Microprocessor Applications in Measurement and Control*, Prentice Hall, 1988.
2. Labrosse J.J.: *Embedded System Building Blocks*, CMP Books, 2000.
3. Daca W.: *Mikrokontrolery od układów 8-bitowych do 32-bitowych*, Wydawnictwo MIKOM, Warszawa, 2000.
4. Janiczek J., Stępień A.: *Mikrokontrolery. Systemy mikroprocesorowe*, Wydawnictwo Centrum Kształcenia Praktycznego, Wrocław, 1997.

OPTIONAL READING:

REMARKS:

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PRINCIPLE OF POWER ELECTRONICS

Course code: 06.2-WE-AIR-UE-PSW_B48_AP_S1S

Type of course: optional

Entry requirements: Engineering physics, Electrical engineering principles, Electronics principles, Metrology

Language of instruction: Polish

Director of studies: Professor Zbigniew Fedyczak

Name of lecturer: Professor Zbigniew Fedyczak

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	15	1	V	Grade	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	9	1	V	Grade	
Class					
Laboratory	18	2		Grade	
Seminar					
Workshop					
Project				Grade	

COURSE CONTENTS:

Introduction. General description (outline) of the preceding course on Fundamentals of power electronics (basic power electronics semiconductor devices, basic power electronics converters, standards and conversion quality evaluation, basic control techniques, application field).

AC/DC and AC/AC converters using phase-angle control. Review of topologies, operation description and properties of non-controlled and controlled (thyristorized) six- and multipulse rectifiers as well as three-phase thyristor choppers. Application examples of such converters.

Conversion quality of the AC/DC and AC/AC converters using phase-angle control. Influence of such converters on a voltage supplying source (displacement factor, deformation factor and power factor).

PWM AC/DC converters. Topologies, operation description and properties of single- and three-phase rectifiers with sinusoidal input current as well as buck and boost type. Suppliers with power factor correction (PFC). The impulse stabilizators control techniques in the suppliers with unity power factor. Integrated monolithic control circuit in the impulse stabilizators.

PWM DC/DC converters II. Operation descriptions and properties of the DC/DC converters with ideal switch circuit models: non-isolated higher level (types Ćuk, ZETA), half- and full bridge and non-isolated (types flyback and forward). Application examples of such converters.

PWM DC/AC converters II. Topologies, operation descriptions and properties of single- and three-phase voltage source and current source inverters (VSI, CSI) with sinus PWM (SPWM) control. PWM control techniques review. Properties of the VSI with space vector PWM (SVPWM) control.

Basic power electronics circuits (general description). Power electronics – historical outline. Application area. Types of power electronic converters (PEC), their classification and basic functions.

LEARNING OUTCOMES:

Skills and competence in understanding and design of basic power electronic converters, knowledge deals with their properties and application fields.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the main condition to get a pass is scoring sufficient marks for all laboratory exercises.

Project – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Pirog S*., Power electronics*, AGH Publishing House, Cracow, 2006 (in Polish).

[2] Mohan N., *Power Electronics: Converters, Application and Design*, John Wiley & Sons, 1998.

[3] Trzynadlowski A., *Introduction to modern power electronics*, John Wiley & Sons, 1998.

[4] Erickson R., W., Maksimowić D.: *Fundamentals of power electronics.* Kluver Academic Publishers, 1999.

OPTIONAL READING:

[1] Mikołajuk K., *Fundamentals of power electronic circuits analysis*, PWN, Warsaw, 1998 (in Polish)

[2] Holms D., G., Lipo T., A.: *Pulse width modulation for power converters. Principles and practice.* John Wiley & Sons Inc., 2003.

REMARKS:

POWER SYSTEM PROTECTION

Course code: 06.2-WE-AiR-AZ-PSW_C49_AP_S1S

Type of course: optional

Entry requirements: Principles of Electrical Engineering, Electronics Principles, Digital Signal Processing, Decision Support Systems

Language of instruction: Polish

Director of studies: Prof. Adam Kempski

Name of lecturer: Prof. Adam Kempski

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	15	1	V	Grade	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	9	1	V	Grade	
Class					
Laboratory	18	2		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Power system faults. Classification of power system faults. Review of faults in power system protection.

Role and functions of protection system in electrical power system (EAZ). General structure. Basic requirements, reliability and redundancy.
Data collection and pre-processing. Current and voltage signals in fault states. Measurement circuits in electrical power protection systems (EAZ). Current and voltage measuring transformers. Measuring transducers in a protection system.
Signal processing in relays and relay protection system. Single- and multi-input relays. Phase and amplitude comparators. Two-state input circuits. Decision circuits. Digital techniques in measurement and data processing protection structures.
Main power system protection criteria and their circuit implementation. Overcurrent criterion. Instantaneous and delayed overcurrent protection. Over- and undervoltage criteria. Differential current protection. Impedance criterion. Distance relays. Angle-current criterion..
Decision-making methods in EAZ systems. Security multiplexing. Adaptive structures.
Relay protection of power system elements. Rules of implementing protection of basic power system elements.

LEARNING OUTCOMES:

Skills and competences in: understanding dependencies between fault conditions and quantity criteria used in protection systems; understanding the operating and application principles of power system protection devices depending on the kind and operation mode of a protected object.

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get positive grades in all written or oral tests carried out at least once a semester.

Laboratory: to obtain a credit a student has to get positive grades for all the tasks designed in the laboratory syllabus.

RECOMMENDED READING:

1. Synal B.: *Elektroenergetyczna automatyka zabezpieczeniowa – podstawy*, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2000.
2. Wiszniewski A.: *Algorytmy pomiarów cyfrowych w automatyce elektroenergetycznej*, WNT, Warszawa, 1990.
3. Winkler W., Wiszniewski A.: *Automatyka zabezpieczeniowa w systemach elektroenergetycznych*, WNT, Warszawa, 2004.
4. Ungrad H., Winkler W., Wiszniewski A.: *Protection techniques in electrical energy systems*, Marcel Dekker Inc., 1995.

OPTIONAL READING:

1. Januszewski M., Kowalik R., Smolarczyk A.: *Cyfrowa elektroenergetyczna automatyka zabezpieczeniowa*, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2006.
2. Wright A., *Electrical Power System Protection*, Springer, 1999.

ESSENTIALS OF NANOTECHNOLOGY

Course code:	06.0-WE-AIR-PN-PSW_C49_AP_S1S
Type of course:	optional
Entry requirements:	Engineering Physics, Electronic Principles, Metrology
Language of instruction:	Polish
Director of studies:	dr hab. inż. Wiesław Miczulski, prof. UZ
Name of lecturer:	academics from the Institute of Electrical Metrology

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	30	2	V	grade	
Project	15	1		grade	
Part-time studies					
Lecture	18	2	V	grade	
Laboratory	9	1		grade	

COURSE CONTENTS:

Aims of micro and nanotechnology.
Devices used for examining nanostructures. Electron, scanning and tunnelling microscopes.
Various types of nanostructures. Nanowires. Carbon and titanium Nanotubes. Manufacturing technologies.
Methods of examining nanostructures. Voltoamperometric and impedance methods.
Application of nanostructures and microstructures - examples. Biosensors. NEMS/MEMS systems.

LEARNING OUTCOMES:

Skills and competences in: description and understanding the essence of micro and nanotechnology, basic knowledge about processes of forming micro and nanomaterials and their applications to micro and nanoelectromechanical systems NEMS/MEMS (Nano-/Micro-Electro-Mechanical Systems).

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get a positive grade in a written test conducted on the last lecture.

Project: to obtain a credit a student has to get a positive grade for a project.

RECOMMENDED READING:

1. Challa S. S. R. Kumar (red.): Nanodevices for the Life Sciences, Wiley, 2006.
2. Robert W. Kelsall, Ian W. Hamley, Mark Geoghegan: Nanoscale Science and Technology, John Wiley & Sons Ltd, 2005.
3. Poole Ch. P.: *Introduction to Nanotechnology*, Wiley, 2003.
4. Guang-Zhong Yang (red.): *Body Sensor Networks*, Springer, 2006.

OPTIONAL READING:

1. www.sandia.gov
2. www.analog.com
3. www.sensirion.com

DIGITAL SIGNAL PROCESSORS AND MICROCONTROLLERS

Course code: 06.5-WE-AIR-PSM-PSW_D50_AP_S1S

Type of course: optional

Entry requirements: Principles of Discrete Systems, Programming with Basics of 3 , Electronics Principles, Computer System Architecture

Language of instruction: Polish

Director of studies: dr inż. Krzysztof Sozański

Name of lecturer: dr inż. Krzysztof Sozański

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	15	1		Grade	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	9	1		Grade	
Class					
Laboratory	18	2		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

History, trends and comparison of digital signal controllers. Basic features of signal controllers. Differences between a DSP and microcontroller and microprocessor.

DSP architecture. Hardware multiplier, Harvard architecture, multibus architecture, pipeline, delayed braches, parallel operations, long accumulator, barrel shifter, circular buffer. Memory addressing modes: direct, indirect, immediate, circular, with bit reversion. Direct memory access systems (DMA). Multiprocessor systems.

Data types used in floating point and fixed point microprocessors. Fixed point and floating point arithmetics.

Fixed-point DSPs. Characteristics of DSP families: ADSP-21x and TMS320C2xx.

DSPs type VLIW (Very Long Instruction Word). Characteristics of DSPs - TMS320C6x.

Floating-point DSPs. Characteristics of floating-point families: ADSP-210xx and TMS320C67xx.

Instruction sets of DSPs - comparison. DSP programming tools. DSP programming with the application of C language. Programming environments: VisualDSP and Code Composer.

Implementation of basic structures of digital signal processing circuits using DSPs. Digital filters FIR and IIR, filter banks, DFT, interpolation and decimation, signal generators. Application of DSPs in video and audio signal processing.

DSP application in control systems. Specialized DSPs for power electronics control circuits: TMS320F24x, TMS320F28x, ADSP2199x.

LEARNING OUTCOMES:

Basic knowledge of: programming digital signal processors (DSP) and microcontrollers; implementation of digital signal processing methods and digital control algorithms using DSPs and microcontrollers.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

4. Martin K., *Digital Integrated Circuit Design (Oxford Series in Electrical and Computer Engineering)*, Oxford University Press, 1999.
5. Embree P.M., Kimble B., *C Language Algorithms for Digital Signal Processing*, Prentice Hall, 1991..
6. Sen M. Kuo and Woon-Seng S. Gan, *Digital Signal Processors: Architectures, Implementations, and Applications*, Prentice Hall, 2004.
7. Stallings W., *Computer Organization and Architecture*, Prentice Hall Inc., 2012.
8. Baer J., *Microprocessor Architecture: From Simple Pipelines to Chip Multiprocessors*, Cambridge University Press, 2009.
9. McFarland G., *Microprocessor Design (Professional Engineering)*, McGraw-Hill Professional, 2006.
10. Chassaing R., Reay D., *Digital signal processing and applications with the C6713 and C6416 DSK*, A John Wiley & Sons, Inc., 2008.

OPTIONAL READING:

2. Chassaing R., *Digital Signal Processing with C and the TMS320C30*, John Wiley & Sons, 1992.

REMARKS:

VISUALIZATION AND MONITORING OF INDUSTRIAL PROCESSES

Course code: 06.0-WE-AIR-WMPP-PSW_D50_AP_S1S

Type of course: optional

Entry requirements: Operating Systems and Computer Networks I and II

Language of instruction: Polish

Director of studies: dr inż. Adam Markowski

Name of lecturer: dr inż. Adam Markowski, academics from the Institute of Electrical Metrology

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	15	1	V	[2] grade	
Laboratory	30	2		[3] grade	
Part-time studies					
Lecture	9	1	V	[4] grade	
Laboratory	18	2		[5] grade	

COURSE CONTENTS:

Introduction. Monitoring and visualisation of industrial processes. The genesis of visualization systems. Structure and functions of visualisation systems - HMI, SCADA. Requirements put forward for visualisation systems. Visualisation systems in the information structure of an enterprise SCADA, MES, ERP. Exemplary applications of visualisation systems.

Elements of visualisation systems. Intelligent measurement-control devices in visualisation systems. Architecture of a communication layer of visualisation systems. Communication protocols in visualisation systems. The use of radio modems in visualization system.

The use of visualization systems. Configuring visualization systems in developing synoptic screens, defining variables, scripting and animation links, configuring alarms and trends, archiving variables, creating reports in text files. The use of advanced modules to create recipes and conduct statistical process control.

Object-oriented technologies in visualization systems. The integration of visualization systems with database systems. The use of object-oriented technology for the exchange of data between the visualization application and industrial automation devices (PLCs).

LEARNING OUTCOMES:

Skills and competences in: creating simple applications for visualising industrial processes within the area of creating synoptic images, alerting variables, tracing varying values in real time, handling archived variables, reporting variables, using advanced tools to create recipes and statistic process control.

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get a positive grade for an end-of-a semester test.

Laboratory: to obtain a credit a student has to get positive grades for all the tasks designed in the laboratory syllabus.

RECOMMENDED READING:

1. Winiecki W., Nowak J., Stanik S.: *Graficzne zintegrowane środowiska programowe do projektowania komputerowych systemów pomiarowo – kontrolnych*, Mikom, Warszawa, 2001.
2. Kwaśniewski J.: *Sterowniki PLC w praktyce inżynierskiej*, , BTC, Legionowo, 2008.
3. Kwiecień R.: *Komputerowe systemy automatyki przemysłowej*, Helion, Gliwice, 2012.
4. *InTouch 9.0 Podręcznik użytkownika,* Astor, Kraków, 2004.
5. *InTouch 9.0 Opis pól i zmiennych systemowych,* Astor, Kraków, 2002.
6. *InTouch 9.0 Menedżer receptur,* Astor, Kraków, 2002.
7. *InTouch 9.0 Moduł SQL Access,* Astor, Kraków, 2002.
8. *InTouch 9.0 Moduł SPC PRO,* Astor, Kraków, 2002.
9. Bailey D., Wright E.: *Practical SCADA for Industry*, Elsevier, London, 2003.

OPTIONAL READING:

1. Jakuszewski R: *Programowanie Systemów Scada*, Pracownia Komputerowa Jacka Skalmierskiego, Gliwice, 2006.

REMARKS:

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WIRELESS SENSOR NETWORKS

Course code: 06.0-WE-AIR-BSS-PSW_E51_AP_S1S

Type of course: optional

Entry requirements: Operating Systems and Computer Networks I and II, Software for Measurement and Control Equipment

Language of instruction: Polish

Director of studies: dr inż. Emil Michta

Name of lecturer: dr inż. Emil Michta

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	15	1	VI	[6] grade	
Laboratory	30	2		grade	

COURSE CONTENTS:

Introduction to sensor networks. Evolution of WPAN wireless networks. Wireless networks IEEE 802.15.x. Processors dedicated for wireless network nodes. Supply of wireless sensor networks. Application areas.
Sensor networks. Sensor networks topology. Physical layer and data layer of wireless sensor networks – standard IEEE 802.15.4. Network layer and application layer – ZigBee standard.
ZigBee. Architecture of ZigBee protocol. Operation of ZigBee network. Types and functions of ZigBee nodes. Central managing and routing. Domains, clusters and profiles in ZigBee networks. Configuration of ZigBee networks. Implementation of security solution on MAC layer, network layer and application layer. Addressing and binding of variables. Application areas and application profiles.
Operating systems for sensor network nodes. TinyOS system. Mantis system. Telos system .
Software distribution in ZigBee networks.
Design and analysis of communication parameters in sensor networks. Selection of a designed network topology. Coordinator and network configuration. Calculation of communication parameters for a designed network. Integration of the sensor networks with computer networks and Internet. Application profiles and examples of applications.

LEARNING OUTCOMES:

Skills and competence in: design and configuration of ZigBee wireless sensor networks; writing application programs in C or Java languages for ZigBee node; creating application profiles for ZigBee; application of security solutions for data transmission protection in ZigBee networks.

ASSESSMENT CRITERIA:

Lecture: to obtain a credit a student has to get positive grades in all written or oral tests carried out at least once a semester.

Laboratory: to obtain a credit a student has to get positive grades for all the tasks designed in the laboratory syllabus.

RECOMMENDED READING:

1. Gislason D.: *ZigBee Wireless Networking*. Elsevier, 2008.
2. Raghavendra C.S., Sivalingam K.M., Znati T.: *Wireless Sensor Networks*. Kluwer Academic Publishers, 2005.
3. Zhao F., Guibas L.: W*ireless Sensor Networks. An Information Processing Approach.* Elsevier, 2004.

OPTIONAL READING:

1. ZigBee Alliance. *ZigBee Specification* v.1.1 2007.

REMARKS:

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PRECISION DRIVES AND INDUSTRIAL ROBOTS

Course code: 06.0-WE-AIR-NPRP-PSW_E51_AP_S1S

Type of course: optional

Entry requirements: Engineering physics, Electrical engineering principles, Electronics principles, Control engineering, Control of electrical drives

Language of instruction: Polish

Director of studies: D.Sc. Robert Smoleński, Ph.D. Jacek Kaniewski

Name of lecturer: D.Sc. Robert Smoleński, Ph.D. Jacek Kaniewski

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	30	2	VI	Grade	
Class					
Laboratory	15	1		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	18	2	VI	Grade	
Class					
Laboratory	9	1		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Servomotors used in robots and robot systems. DC motors (conventional and disc), synchronous motors permanent magnet and reluctance, step motors and asynchronous. Power electronic converter servo drives.

Control methods of electric drives. Scalar control. Field oriented control. Direct torque control. Sensorless control.

Open and closed loop control of speed, torque and position. Realization of four-quadrant direct and alternating current drives. Follow-up and position servo drives, precise drives. Robot drives. Sensor systems of robots.

LEARNING OUTCOMES:

Skills and competences in: principles of servo-motors operation and their static and dynamic characteristics; selection of drives according to mechanical requirements of the driven machine; development of electric drives, knowledge of drive basics and robot kinematics.

ASSESSMENT CRITERIA:

Lecture – in order to get a credit it is necessary to pass all of the required tests (oral or written)

Laboratory - in order to get a credit it is necessary to earn positive grades for all laboratory works defined by tutor

RECOMMENDED READING:

1. Kaźmierkowski M. P., Tunia H.: Automatic Control of Converter-Fed Drives, Warsaw - Amsterdam - New York - Tokyo: PWN-ELSEVIER SCIENCE PUBLISHERS, 1994.
2. Kaźmierkowski M. P., Blaabjerg F., Krishnan R.: Control in Power Electronics, Selected Problems, Elsevier 2002.
3. Boldea I., Nasar S.A, Electric Drives, CRC Press, 1999.
4. Kaźmierkowski M. P. and Orłowska-Kowalska T.: Neural Network estimation and neuro-fuzzy control in converter-fed induction motor drives, Chapter in Soft Computing in Industrial Electronics, Springer-Verlag, Heidelberg, 2002.
5. Leonhard W.: Control of Electrical Drives, Springer, Berlin, New York, 2001.
6. Miller T.J.E.: Brushless Permanent-Magnet and Reluctance Motor Drives, Oxford University Press, Oxford, England, 1989.
7. Ryoji O.: Intelligent sensor technology, John Willey & Sons, 1992.
8. Samson C., Le Borgne M., Espinau B.: Robot control. Oxford University Press, 1991.
9. Canudas C., Siciliano B., Bastin G.: Theory of robot control. Springer Verlag, 1996.

OPTIONAL READING:

REMARKS:

DIAGNOSTICS OF INDUSTRIAL PROCESSES

Course code: 06.0-WE-AIR-DPP-PS44_KSSD_S1S
Type of course: optional
Entry requirements: Modelling and simulation, Methods of data analysis, Methods of artificial intelligence.
Language of instruction: Polish/English
Director of studies: Professor Józef Korbicz
Name of lecturer: Professor Józef Korbicz

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	30	2	V	Exam	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	18	2	V	Exam	
Class					
Laboratory	18	2		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Introduction to the diagnostics of processes. Basic tasks and notations, aim of diagnostics, concept of diagnostic systems, classification of fault detection and localisation methods.

Models in process diagnostics. Fault detection: physical equations, state equations of linear systems, state observers (Kalman and Luenberger filters), transfer functions of linear systems, neural and fuzzy models. Fault localisation: binary diagnostic matrix, diagnostic trees and graphs, rules and logic functions.

Fault detection

Methods of limit checking. Reliability checking.

Methods of signal analysis. Analysis of statistical signal parameters, spectral analysis.

Analytical detection methods. Analytical redundancy: generation of residuals using: transfer function of linear systems, parity and state equations, state observers, parametric identification of the process model.

Intelligent computations in detection systems. Neural models: multilayer perceptron, recurrent networks, GMDH-type networks. Fuzzy models: Wang and Mendel models, Takagi-Sugeno-Kang (TSK) fuzzy neural networks.

Fault localisation

Bank of observers. Structure of banks, unknown input observers, robust bank of observers.

Pattern recognition methods. Classical methods: geometrical, statistical and polynomial. Neural classifiers: multilayer perceptron, Kohonen-type networks.

Binary diagnostic matrices. Conditional probability of system states, probabilistic inference.

Application of fuzzy logic. Fuzzy residual evaluation, fuzzy diagnostic inference, fuzzy neural networks.

Advisory systems in technical diagnostics. Knowledge representation, statement and rules, static and dynamic advisory systems, inference in belief networks.

Industrial applications. Fault diagnosis of the evaporation station in a sugar factory: system description, fault detection and localisation in the evaporator.

LEARNING OUTCOMES:

Skills and competences in the field of the design of fault detection and localisation systems by using analytical methods mainly known from control theory and artificial intelligence ones – artificial neural networks, fuzzy logic and advisory systems.

ASSESSMENT CRITERIA:

Lecture: successful completion of the course requires passing the final examination.

Laboratory: successful completion of the course requires completing all laboratory activities.

RECOMMENDED READING:

1. Korbicz J., Kościelny J. M., Kowalczuk Z. and Cholewa W. (Eds), *Fault Diagnosis. Models, Artificial Intelligence, Applications,* Springer-Verlag, Berlin, 2004.
2. Korbicz J., Kościelny J. M.(Eds.), *Modeling, Diagnostics and Process Control. Implementation in the DiaSter System,* Springer-Verlag, Berlin, 2010.
3. Isermann R., *Fault Diagnosis Systems. An Introduction from Fault Detection to Fault Tolerance*, Springer-Verlag, New York, 2006.
4. Patton R. J., Frank P. M. and Clark R. N. (Eds), *Issues of Fault Diagnosis for Dynamic Systems*, Springer-Verlag, Berlin, 2000.
5. Blanke M., Kinnaert M., Lunze J. and Staroswiecki M., *Diagnosis and Fault-Tolerant Control*, Springer-Verlag, New York, 2003

OPTIONAL READING:

REMARKS:

INDUSTRIAL AUTOMATION EQUIPMENT

Course code: 06.0-WE-AIR-UAP-PS45_KSSD_S1S
Type of course: compulsory
Entry requirements: Control theory
Signals and systems
Language of instruction: Polish
Director of studies: Prof. Andrzej Janczak
Name of lecturer: Prof. Andrzej Janczak

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					
Lecture	15	2	V	Grade	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	9	1	V	Grade	
Class					
Laboratory	18	2		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Introduction. Control tasks and functional elements of control systems. Types of industrial automation components and equipment and their specifications. Specifications of electronic and electrical automation components and equipment. Relays, reed relays, bimetallic overload relays, controllers. Sensors and transducers.

Controllers. Controller types, properties and specifications. Self-actuated controllers. PID controllers, on-off controllers. Digital controllers. Control specification and performance indices. PID controller tuning methods.

Programmable logic controllers (PLC). PLC functionality, features, types and choice rules. I/O modules, connecting PLC to sensors and actuators. Programming methods and languages. Communication ports and protocols.

Electrical actuators. Actuator types and their specifications. Advantages and disadvantages of electrical actuation. Electrical servo motors and actuators. Basic principles of AC and DC servo motors and stepper motors.

Pneumatic automation equipment. Pneumatic components, their types and classification. Pneumatic symbols. ***Air preparation units, pressure regulators, filters, and lubricators.***

Pneumatic actuators***. Types, specifications, and applications. Pneumatic motors: types, specifications, and applications.***

Pneumatic valves***. Air flow and air pressure control valves: directional control valves, flow control valves, shutoff valves, throttle valves, non-return valves, pressure control valves, air distribution valves. Blocks of valves and valve islands.***

Pneumatic system designing***. Design calculations for pneumatic systems. Designing, modeling and simulation of pneumatic and electropneumatic circuits using FluidSim 4 Pneumatics software.***

LEARNING OUTCOMES:

Skills and competencies needed to choice industrial automation components and equipment. Skills and competencies needed to design and model basic pneumatic and electropneumatic control systems.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass is a sufficient number of positive evaluations of written or oral tests conducted at least once per semester.

Laboratory – the main condition to get a pass is a positive assessment of the laboratory tasks assigned by the lecturer.

RECOMMENDED READING:

1. P. Croser, F. Ebel, *Pneumatics. Basic Level*. Festo Didactic GmbH & Co., Denkendorf, 2000
2. A.K. Gupta, *Industrial Automation and Robotics: An Introduction*. Mercury Learning & Information, 2013
3. G. Prede, D. Scholz, *Electropneumatics. Basic Level*. Festo Didactic GmbH & Co., Denkendorf, 2002
4. J. Stenerson, *Industrial Automation and Process Control*. Prentice Hall. 2002

OPTIONAL READING:

1. S. Medida, *Pocket Guide on Industrial Automation. For Engineers and Technicians*. IDC Technologies, 2007 (www.PAControl.com)
2. *FluidSim 4 Pneumatics. Users Guide*. Festo Didactic GmbH & Co., Denkendorf, 2007

EMBEDDED SYSTEMS

Course code: 06.0-WE-AIR-SW-PS46_KSSD_S1S
Type of course: compulsory
Entry requirements:
Language of instruction: Polish and English
Director of studies: Arkadiusz Bukowiec, Ph.D.
Name of lecturer: Arkadiusz Bukowiec, Ph.D.
Grzegorz Andrzejewski, Ph.D.
workers of WEIT IIE

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	30	2	V	Grade	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	18	2	V	Grade	
Class					
Laboratory	18	2		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

General information: characteristic, structure, embedded system requirements, Real time systems. Reactive systems.

Design: Specification, modelling, verification, implementation. Formal specification models – FSM, CFSM, Statechart. Hardware/Software Co-design.

Real time systems: time requirements, process state, priorities, task planning, common resources, race conditions, critical regions.

Parallel processes: processes and communication, information transfer, common resources, deadlocks, semaphores, monitors.

Interfaces and communication: bus, ports, protocol concept, interrupts and interrupts handling, DMA, bus arbiters, serial protocols, parallel protocols, wireless protocols.

Printed Circuit Boards: electronic circuits design, netlists, packages, PCB design, PCB technologies, mounting.

LEARNING OUTCOMES:

Abilities and competence: embedded system design and programming, with aspects of specification, modelling and implementation; communication interface design; real time systems; parallel systems.

ASSESSMENT CRITERIA:

Lecture – in order to get a credit it is necessary to pass all tests carried on at last once per semester or exam

Laboratory – in order to get a credit it is necessary to earn positive grades for all laboratory works defined by tutor

RECOMMENDED READING:

1 Ben-Ari M.: *Principles of Concurrent and Distributed Programming*, Prentice Hall, 2006

2 Calvez J. P..: *Embedded* Real-*Time Systems*, John Wiley & Sons, 1993

3 Vahid F., Givargis T.: *Embedded System Design: A Unified Hardware/Software Introduction,* John Wiley & Sons, 2002

4 A. A. Jarraya et al.: *System-Level Synthesis*, Kluwer Academic Publishers, 1999

OPTIONAL READING:

1. F. Balarin et al.: *Hardware-Software Co-Design of Embedded Systems*, Kluwer Academic Publishers, 1997
2. J. Staunstrup et al.: *Hardware/Software Co-Design: Principles and Practice*, Kluwer Academic Publishers, 1997
3. J. Van den Hurk et al.: *Hardware/Software Co-Design: An Industrial Approach*, Kluwer Academic Publishers, 1998

WIRELESS COMMUNICATION

Course code: 06.0-WE-AIR-KB-PS47_KSSD_S1S
Type of course: compulsory
Entry requirements: Electronics, [06.5-WE-AIR-PTCM-PK26_S1S]
Language of instruction: English
Director of studies: Dr. Robert Dąbrowski
Name of lecturer: Dr. Robert Dąbrowski

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					2
Lecture	15	1	V	Exam	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	9	1	V	Grade	
Class					
Laboratory	18	2		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Introduction to wireless communication. Basic definitions, describing of a variety of transmission media, overview of connecting topologies, classification of transmission types.

Communication using optic medium. Standard IrD, applying infrared and laser lights, design both the hardware and software parts.

Short distance radio transmission. Comparing the parameters of Bluetooth and ZigBee standards, communication in the narrow frequency band, starting up and testing this communication equipment.

Broadband wireless communication. Overview the local network for example WiFi and metropolitan network for example WiMax.

Radio modems. Types Overview. Construction and working principles.

Mobile communication. The GSM and UMTS standards, overview of a GSM modem units, data transmission in the GSM network.

Navigation systems; The GPS, Galileo and Glonass standard, differential systems, using a navigation system as a timing source.

Cryptography and data compression. Data transmission without loss of information, auto-correction of transmission errors

LEARNING OUTCOMES:

Basic knowledge and skills regarding various wireless transmission standards, designing and selecting the interface system depending on specific requirements, starting up and testing wireless communication systems, design of hardware as well as software for wireless communication units.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written tests conducted at least once per semester.

Laboratory – the main condition to get a pass is scoring sufficient marks for all laboratory exercises.

RECOMMENDED READING:

1. Dick Eastman, *The Latest in GPS Technology,* Copyright by Dick Eastman, 2007
2. L.e Harte, Introduction to Data Networks, 2nd Edition ALTHOS Publishing, 2006
3. S. Gibilisco, *Handbook of Radio and Wireless Technology,* McGraw-Hill, 1998
4. L. Harte, *Wieless technology Basics,* ALTHOS Publishing, 2004
5. L. Harte, D. Eckard, *Introduction to Optical Communication,* ALTHOS Publishing, 2006
6. L. Harte, *Introduction to GSM, 2nd Edition* ALTHOS Publishing, 2009
7. L. Harte, B. Levitan *GPS Quick Course Book,* ALTHOS Publishing, 2007

OPTIONAL READING:

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DIGITAL MICROSYSTEMS IN CONTROL SYSTEMS

Course code:	06.2-WE-AIR-MCSS-PSW_B48_KSSD_S1S
Type of course:	optional
Entry requirements:	Foundations of discrete systems, Computer system architecture, Foundations of digital and microprocessor engineering, Discrete process control, Programming with basics of algorithmics
Language of instruction:	Polish/English
Director of studies:	Dr. Marek Węgrzyn
Name of lecturer:	Dr. Grzegorz Andrzejewski, Dr Arkadiusz Bukowiec

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	15	1	V	Grade	
Class					
Laboratory	30	3		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	9	1	V	Grade	
Class					
Laboratory	18	2		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

General information: digital microsystem characteristics, structure and working. Review of producers and systems.

Design: Classical design and hardware/software co-design of hybrid systems. Modelling, verification, implementation languages – ANSI C, VHDL.

System decomposition: algorithms of decomposition, CAE tools for decomposition.

Communication: ways for data transmission between hardware and software modules, memory sharing.

Software packages: POLIS, ATMEL System Designer, Aldec A-HDL.

Analog interface: analog signals acquisition, analog signal shaping, A/D and D/A converters, pulse-width modulation, real time clock, supervision systems.

LEARNING OUTCOMES:

Abilities and competence: design and programming of digital microsystems, hardware/software co-design, integration of analog and digital technologies.

ASSESSMENT CRITERIA:

Lecture – in order to get a credit it is necessary to pass all tests carried on at last once per semester

Laboratory – in order to get a credit it is necessary to earn positive grades for all laboratory works defined by tutor

RECOMMENDED READING:

1. G.DeMicheli, Readings in Hardware/Software Codesign, Morgan Kaufmann, 2001
2. R.Plassche, CMOS Integrated Analog-To-Digital and Digital-To-Analog Converters, Kluwer Academic Pub, 2003
3. F.Vahid, Digital Design, Wiley, 2006
4. M. Zwolinski, Digital System Design with VHDL, 2nd Edition, Prentice-Hall, 2003

OPTIONAL READING:

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HARDWARE CONTROL SYSTEMS

Course code: 06.2-WE-AIR-SSS-PSW_B48_KSSD_S1S

Type of course: optional

Entry requirements: Foundations of discrete systems, Programming with basics of algorithmic, Computer system architecture, Electronics principles, Foundations of digital and microprocessor engineering

Language of instruction: Polish/English

Director of studies: Dr. Marek Węgrzyn

Name of lecturer: Dr. Marek Węgrzyn

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	15	1		Grade	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	9	1		Grade	
Class					
Laboratory	18	2		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Basics of digital circuits. Basic logic gates. Basic sequential circuits: latches and flip-flops. Combinatorial and sequential digital functional blocks.

Decomposition of digital circuit: datapath and control unit. Specification of datapath and control unit of digital systems. Finite State Machines (FSMs). Moore and Mealy state machines. Finite state machines representations.

Introduction to control digital systems design using VHDL language. VHDL basics. VHDL level abstraction. The VHDL design flow. Modeling hardware in VHDL. VHDL design entities. Architecture (declarations and body). Using libraries and packages. Concurrent signal assignments. Signal assignments with delay. Hierarchy in VHDL. Processes.

Simulation and Synthesis. Event-driven simulation. Process synthesis. Synthesisable processes styles & templates. Intellectual Property (IP) Cores design using VHDL language. Control digital systems implementation using programmable logic devices.

LEARNING OUTCOMES:

Ability to analyze and synthesize logic circuits. Basic understanding of datapath and control unit design. Basic knowledge of modeling and design of control digital systems and reactive embedded systems using VHDL and programmable logic.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the main condition to get a pass is scoring sufficient marks for all laboratory exercises

RECOMMENDED READING:

1. S. Brown and Z. Vranesic, Fundamentals of Digital Logic with VHDL Design, McGraw-Hill, 2000
2. A. Rushton, VHDL for Logic Synthesis, 2nd Edition, John Wiley & Sons Ltd., 1998
3. K. Skahill, VHDL for Programmable Logic, Addison-Wesley Publishing, 1996
4. M. Zwolinski, Digital System Design with VHDL, 2nd Edition, Prentice-Hall, 2003

OPTIONAL READING:

5. P. J. Ashenden, The Designer's Guide to VHDL, Morgan Kaufmann Publishers, 1996
6. P. A. Laplante, Real-Time Systems Design and Analysis. An Engineer's Handbook, IEEE Computer Society Press, 1993
7. F. P. Prosser and D. E. Winkel, The Art of Digital Design. An Introduction to Top-Down Design, Prentice-Hall, 1987

DIGITAL CONTROL ALGORITHMS

Course code: 06.2-WE-AIR-ASC-PSW_C49_KSSD_S1S
Type of course: optional
Entry requirements: Control engineering. Signals and dynamic systems.
Language of instruction: Polish
Director of studies: Dr. Wojciech Paszke, Prof. Andrzej Janczak
Name of lecturer: Wojciech Paszke

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	15	1	VI	Grade	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	9	1	VI	Grade	
Class					
Laboratory	18	2		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Introduction to digital control. Digitization. Sampling results. Linear difference equations. Quantization and Quantization errors. Round off error analysis. Word-size effects. Pulse transfer function of discrete systems. Discrete models of sampled systems. The z-transform properties

Sample Rate Selection. Nyquist-Shannon sampling theorem. Time response and smoothness. Limitations on control performance In system with varying inputs or disturbances. Sensitivity to parameter value changes. Measurement noise and anti-aliasing filters.

Sampled signal systems. Sample and hold system analysis. Sampled signal spectrum. Data extrapolation. Analysis of sampled signal system.

Design of digital control systems and algorithms. Design by emulation. Direct digital design by matched pole-zero (MPZ) method. Frequency response and frequency response techniques. Design via direct method of Ragazzini. Design and practical implementation of PID controller and lead-lag compensators.

Design via state spaces. A state feedback method. Observer design. Controller design - combined state feedback control law and a state estimator. Introduction of the reference input; reference signal tracking problem. Integral feedback control and disturbance attenuation. Influence of time delay on control performance. Controllability and observerability**.**

LEARNING OUTCOMES:

Analysis of quantization and sampling effects. Design and development of Digital control systems and algorithms, implementation of digital control algorithms; Developments of Matlab routines for digital control system design and digital control problems solving.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the main condition to get a pass is scoring sufficient marks for all laboratory exercises.

PROJECT - THE MAIN CONDITION TO GET A PASS IS POSITIVE GRADE FOR PREPARED PROJECT.RECOMMENDED READING:

1. Franklin G. F., Powell J. D., Workman M. L.: *Digital Control of Dynamic Systems* Addison Wesley;,1998.
2. Ogata K.: *Discrete-Time Control Systems*, Prentice Hall; 1994
3. Shahian B., Hassul M. :*Control System Design Using MATLAB*, Prentice Hall, New Jersey,1993.

OPTIONAL READING:

1. Nise N.S.: *Control Systems Engineering*, 6th Edition International Student Version, John Wiley & Sons, Inc. , 2011.
2. Franklin G.E, Powell J.D. Emami-Naeini A.: *Feedback Control of Dynamics Systems.* Addison-Wesley, Upper Saddle River, New Jersey, 2002

REMARKS:

COMPUTER VISION SYSTEMS

Course code: 06.0-WE-AIR-SW-PSW_C49_KSSD_S1S
Type of course: optional
Entry requirements: Fundamentals of robotics, Digital signal processing, Decision support systems
Language of instruction: English
Director of studies: Dr. Bartłomiej Sulikowski
Name of lecturer: Dr. Bartłomiej Sulikowski

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	15	1	VI	Grade	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project					
Part-time studies					
Lecture	9	1	VI		
Class					
Laboratory	18	2			
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Digital image representation. Graphic file formats. Dissipative and lossless representations.

Image acquisition. Visible light waves. Infrared and ultraviolet spectrum. Optics. Image digitizing. Shannon theorem.

Pre-processing. Histogram transformations (normalization, equalization).

Global and local transformations. Fourier transform. Hadamard transform. Linear and nonlinear operators.

Segmentation methods. Thresholding. Clustering.

Edge detection. Local operators: gradient and Laplace operator.
Edge approximation –Hough transform.

Morphological operations. Dilatation and erosion. Contour extraction. Closing. Opening.

Feature extraction and classification.

Stereovision.

Images in robots control. Recognition, Localization. Orientation.

LEARNING OUTCOMES:

Knowledge of methods of image processing and classification used in robotic vision systems. Special emphasis will be placed on image acquisition, pre-processing, object segmentation, feature extraction and classification.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the main condition to get a pass is scoring sufficient marks for all laboratory exercises.

RECOMMENDED READING:

[1] Horn B. K. P., *Robot Vision*, MIT Press, McGraw--Hill, 1986

[2] Acharya T.: *Image processing: principles and application*, John Wiley and Sons, 2005.

[3] Ballard D.H., Brown C.M.: *Computer Vision* , Prentice-Hall Inc New Jersey, 1982,

[4] Gonzales R. C., Wintz P., *Digital Image Processing*, Addison--Wesley, London, 1977.

[5] Kamel M.: *Image Analysis and Recognition*, Springer, LNCS 3212, 2004.

OPTIONAL READING:

[1] Weisstein E.W.: *Mathworld,* (online course)

[2] Young I.T., Gerbrands J.J., van VlietL.J.: *Image Processing Fundamentals,* (online course)

REMARKS:

COMPUTER-AIDED CONTROL SYSTEMS DESIGN

Course code: 06.0-WE-AIR-KWPUS-PSW_D50_KSSD_S1S

Type of course: optional

Entry requirements: Signals and dynamic systems, Control engineering, Digital control algorithms

Language of instruction: English

Director of studies: Dr. Bartłomiej Sulikowski

Name of lecturer: Dr. Bartłomiej Sulikowski

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	30	2	VI	Exam	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project	15	1		Grade	
Part-time studies					
Lecture	18	2	VI		
Class					
Laboratory	18	2			
Seminar					
Workshop					
Project	9	1			

COURSE CONTENTS:

Computer-aided design environments. Survey and classification of existing software packages: Matlab. MathCAD. Mathematica. Integrating the packages with the environment. Basics of programming and data structures. Automatic control systems synthesis using the computer-aided tools.

Matlab Simulink Toolbox. Structure, data exchange with Matlab. Block diagrams design. Linear and non-linear elements. Continuous and discrete elements. Impulsive elements, generators and receivers. Clustering, linearization, equilibrium points setting. Simulation initiation. Design examples in Matlab/Simulink. Intregration Simulation with Real Time Workshop. StateFlow and ControlShell packets.

Physical objects models. Automatic control systems design process. Object model. Design aims. Models types. Mathematical model, discrete and continuous models. Modelling the physical objects. Model accuracy. Model evaluation methods and tools. Tools of model analysis. Application of computer packages to aforementioned topics.

LEARNING OUTCOMES:

Ability to apply modern design, analysis and testing methods of automatic control systems. Fluency in Matlab programming.

ASSESSMENT CRITERIA:

Lecture – the main condition is passing the written exam

Laboratory – the main condition to get a pass is scoring sufficient marks for all laboratory exercises.

Project – the pass is upon implementing the design of the control scheme

RECOMMENDED READING:

[1] *Matlab/Simulink documentation*. MathWorks, Inc., 2000

[2] Franklin G. F., Powell J. D., Workman M. L.: *Digital Control of Dynamic Systems* Addison Wesley;,1998.

[3] Ogata K.: *Discrete-Time Control Systems*, Prentice Hall; 1994

[4] Shahian B., Hassul M. :*Control System Design Using MATLAB*, Prentice Hall, New Jersey,1993.

[5] *Control System Toolbox for Use with MATLAB*. User's Guide. MathWorks, 1992.

OPTIONAL READING:

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REMARKS:

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MOBILE APPLICATION DESIGN

Course code: 11.3-WE-AIR-PAM-PSW_E51_KSSD_S1S
Type of course: compulsory
Entry requirements: Programming with basics of algorithmics, Object-oriented programming
Language of instruction: Polish
Director of studies: dr. inż. Andrzej Popławski
Name of lecturer: dr. inż. Andrzej Popławski

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					5
Lecture	30	2	VI	Grade	
Class					
Laboratory	30	2		Grade	
Seminar					
Workshop					
Project	15	1		Grade	
Part-time studies					
Lecture	18	2	VI	Grade	
Class					
Laboratory	9	1		Grade	
Seminar					
Workshop					
Project					

COURSE CONTENTS:

Introduction – idea and significance of mobile application
Concepts of mobile systems
Mobile phone systems

Structure and action of GSM system

Present day communication systems (satellite, LAN, ultrasound, IrDA, Bluetooth)

Satellite navigation systems

Problems in mobile application design

Military deployment of mobile application

LEARNING OUTCOMES:

Abilities and competence in design and implementation mobile application for chosen platforms.

ASSESSMENT CRITERIA:

Lecture – in order to get a credit it is necessary to pass all tests (oral or written) carried on at last once per semester.

Laboratory – in order to get a credit it is necessary to earn positive grades for all laboratory works defined by the tutor.

Project – in order to get a credit it is necessary to earn positive grades for all project works defined by the tutor.

RECOMMENDED READING:

1. Conder S., Darcey L.: Android. Programowanie aplikacji na urządzenia przenośne. Gliwice, Helion, 2011
2. Gala P.: Symbian S60. Programowanie Urządzeń Mobilnych, Gliwice, Helion, 2010
3. Zienkiewicz R.: Telefony komórkowe GSM I DCS, Warszawa, WKŁ, 1999
4. Flickenger R.: Sto sposobów na sieci bezprzewodowe, Gliwice, Helion, 2004
5. Roshan P., Leary J.: Bezprzewodowe sieci LAN 802.11, Warszawa, Mikom, 2004
6. Friesen J.: Java. Przygotowanie do programowania na platformę Android, Helion, Gliwice, 2011
7. Conder S., Darcey L.: Android Wireless Application Development. Addison-Wesley Professional, 2011
8. Friesen J.: Learn Java for Android Development, Apress2010

OPTIONAL READING:

REMARKS:

INFORMATION SYSTEMS DESIGN

Course code: 06.0-WE-AIR-PSI-PSW_E51_KSSD_S1S

Type of course: optional

Entry requirements: Database systems

Language of instruction: Polish / English

Director of studies: Wojciech Zając, PhD

Name of lecturer: Jacek Bieganowski, PhD

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					5
Lecture	30	2		grade	
Laboratory	30	2		grade	
Project	15	1		grade	
Part-time studies					
Lecture	18	2		grade	
Laboratory	9	1		grade	
Project	9	1		grade	

COURSE CONTENTS:

Basic concepts. The concept of an information system and information technology. Design process location in the life cycle of the system. Design methodologies. Applications. Stages of design. CASE tools and techniques.

The life cycle of the system. Phases of the construction of the system: strategic, identifying user requirements, analysis, design, implementation, installation, testing, maintenance.

The analysis and structural design. Modelling the entities relations - basic conventions and definitions (entities, unions, fields, attributes).

Object-oriented analysis and design. Technology, notation, tools. Unified Modelling Language UML.

Designing a user interface. Text and graphical interfaces. Interface ergonomics.

CASE tools. Presentation of selected tools with special emphasis on ones that support the creation of database information systems.

LEARNING OUTCOMES:

Abilities and competence in: Information System (IS) design stages: analysis, design, coding, testing, implementation and maintenance; analysis and modelling of user requirements; use of computer-based tools for IS systems design; user interface realisation techniques; design of IS systems in context of database applications

ASSESSMENT CRITERIA:

Lecture – written test.

Laboratory – written test

RECOMMENDED READING:

1. Meek J.L. Communications in Applied Numerical Method. John Wiley & Sons, Ltd, 1992
2. Susan M. Weinschenk, GUI Design Essentials. Wiley Computer Publishing 1997.
3. Roszkowski J.: Anaysis and structural programming, Helion, Gliwice, 2002 (in Polish)
4. Barker R.: Case Method SM Function and Process Modeling, Addison-Wesley, 1992

OPTIONAL READING:

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REMARKS:

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