FACULTY OF MECHANICAL ENGINEERING

THE OFFER STUDIES FOR FOREIGN STUDENTS IN THE FRAMEWORK OF THE ERASMUS PROGRAMME:

BIOMEDICAL ENGINEERING

THE OFFER OF SUBJECTS FOR AREA OF STUDY: **BIOMEDICAL ENGINEERING**

(MINIMUM NUMBER OF HOURS AND ECTS)

	Offer of Subjects in English	**Numbers of hours**	**ECTS**
1.	Automated Medical Diagnosis System	60	5
2.	Biophysics	45	3
3.	Computer Graphics	60	5
4.	Entrepreneurship and Quality Control	60	4
5.	Heat and Flow Problems in Biological Systems	60	4
6.	Implants and Artificial Organs	30	3
7.	Mechanics and Strength of Materials	60	5
8.	Test Methods for Biomaterials	60	4
9.	Numerical Methods	45	4
10.	Programming Languages	60	5
11.	Mobility Rehabilitation	60	4
12.	Sensors and Non-Electrical Quantities Measurement	60	3

AUTOMATED MEDICAL DIAGNOSIS SYSTEMS

Course code: 6.9-WM-IB-D-2

Type of course: Compulsory

Language of instruction: Polish/English

Director of studies: Dr inż. Katarzyna Arkusz

Name of lecturer: Dr inż. Katarzyna Arkusz

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

COURSE AIMS:

- familiarize students with the methods of data collection used in medical diagnosis and the development of skills in the pre-processing of medical data

- familiarize students with the architecture of medical data warehouse and development of skills in the designing and application of analytical systems for medical data

- familiarize students with the methods used to build automated medical diagnosis systems and development of skills allowing the use of decision support and data mining algorithms

PREREQUISITES:

medical imaging techniques, digital signal processing, statistical methods of data analysis

COURSE CONTENTS:

Methods of data acquisition and processing for automated medical diagnosis.

Radiological imaging. Virtual microscopy. Application of image segmentation algorithms for the extraction of morphometric features. Feature selection methods. Discovering outliers. Completing the missing data.

Methods of storage and analysis of medical data. Medical data warehouse architecture. Analytical systems. Multidimensional data structures. Statistical analysis. Reporting methods and services. Analytical systems review. Overview of public repositories of medical data.

Medical decision support systems. Expert systems. Methods of knowledge representation. Methods of knowledge discovery. Classification algorithms. Artificial intelligence

methods. Medical decision support systems - case studies. Integration of decision support systems with picture archiving and communication systems.

TEACHING METHODS:

Lectures - conventional lecture, discussion

Laboratory - laboratory exercises, case studies

LEARNING OUTCOMES:

Field specific learning outcomes	Knowledge, skills, competence
K_W23	The student can name and explain image segmentation methods, he can apply these methods to extract objects from images and compute their morphometric parameters.
K_W23	The student knows and can explain methods of outlier detection and missing data handling.
K_U27	The student can name and define feature selection algorithms and he can apply these methods for medical data.
K_U27	The student can characterize components of a data warehouse.
K_U27	The student can design and build multidimensional data structure using star schema.
K_U27	The student can explain how the expert system is built and he knows methods of knowledge representation.
K_U27	The student can interpret the results of data analysis and write the report.
K_U27	The student can name and define data mining techniques used for association and sequence discovering, clustering and classification.
K_U27	The student know how to apply learned data mining methods to explore medical data.

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

The reference to the learning outcomes of the field of study	The method of the learning outcomes assessment
K_W23	The main condition to get a pass is positive grade in written test conducted once per semester.
K_U27	Grade based on laboratory classes. A passing grade in laboratory part comprises positive evaluation of reports based on each laboratory class, and preparation for classes.

final evaluation = 0.5 assessment of the lecture + 0.5 assessment of the laboratory.

STUDENT WORKLOAD:

Full-time studies

The student workload of 150 hours (6 ECTS), including contact hours 60 hours, consultations 15 hours, preparing for classes 30 hours, preparing for exam 15 hours, preparing of control work and reports 15 hours, reading literature 15 hours.

RECOMMENDED READING:

1. Piętka E.: *Zintegrowany system informacyjny w pracy szpitala*, PWN, 2004.
2. Rudowski R. (red.): *Informatyka medyczna*, PWN, 2003.
3. Cytowski J., Gielecki J., Gola A.,: *Cyfrowe przetwarzanie obrazów medycznych. Algorytmy technologie zastosowania.*, AOW EXIT,2008
4. Nieniewski M.: *Segmentacja obrazów cyfrowych. Metody segmentacji wododziałowej*. AOW EXIT, 2005.
5. Hand D., Mannila H., Smyth P.: *Eksploracja danych*. WNT, 2005.
6. Kisielnicki J., Pańkowska M., Sroka H.: *Zintegrowane systemy informatyczne. Dobre praktyki wdrożeń,* Warszawa, PWN, 2011.
7. Larose T. D.: *Odkrywanie wiedzy z danych*, Warszawa, PWN, 2006.
8. Larose D. T.: *Metody i modele eksploracji danych*, Warszawa, PWN, 2008.
9. Pelikant A.: *Hurtownie danych. Od przetwarzania analitycznego do raportowania*, Helion, 2011.

OPTIONAL READING:

10. Kącki E., Kulikowski J.L., Nowakowski A., Waniewski E. (red.): *Systemy komputerowe i teleinformatyczne w służbie zdrowia*. AOW EXIT, 2000.Zajdel R., Kęcki E., Szczepaniak P., Kurzyński M.: *Kompendium informatyki medycznej*, Alfa-Medica Press, 2003.
12. Cierniak J.: *Tomografia komputerowa. Budowa urządzeń CT. Algorytmy rekonstrukcyjne.*
13. Klonecki W.: *Statystyka dla inżynierów*. PWN. 1999.
14. Cantor A.B.: *Survival Analysis Techniques for Medical Research*. SAS, 2007.
15. Suri J. S., Setarehdan K, Singh S. (red.): *Advanced Algorithmic Approaches to Medical Image Segmentation*. Springer, 2002.

BIOPHYSICS

Course code: 6.9-WM-IB-P-17

Type of course: Compulsory

Language of instruction: Polish/Russian/English

Director of studies: Dr hab. Jarosław Piskorski, prof. UZ

Name of lecturer: Dr hab. Jarosław Piskorski, prof. UZ

Form of instruction	teaching hours per	teaching hours per	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	30	2	III	Grade	
Laboratory	15	1		Grade	

COURSE AIMS:

The aim of the course is to teach the foundations of biophysics to the extent which is both necessary and useful in biomedical engineering.

PREREQUISITES:

Basic Physics Course

COURSE CONTENTS:

1) Static forces: equilibrium considerations for the human body, skeletal muscles, levers, the elbow, the hip,

2) Friction: standing and moving on an incline, friction at joints,

3) Translational motion: jump – maximum standing and running jump and vault poling, energy considerations,

4) Angular motion: running: running on a curved track, pendulum and walking, speed of running, model of walking and running,

5) Elasticity and strength of materials: longitudinal stretch and compression, spring, bone fracture: energy and impulse force considerations, injuries in car accidents, osteoarthritis and exercise,

6) Fluids: force and pressure in fluids, Pascal's principle, hydrostatic skeleton, Archimedes' principle, power required for floating, surface tension,

7) Motion of fluids: Bernouli's equation, viscosity and Poiseuille law, turbulent flow, circulation of the blood, blood pressure, control of blood flow, turbulence in the blood, arteriosclerosis and blood flow, power produced by the heart, blood pressure measurement,

8) Heat and Kinetic Energy: Heat and hotness, kinetic theory of matter, basic definitions, transfer of heat, transfer of molecules by diffusion, diffusion through membranes, the respiratory system, surfactants and breathing, diffusion and contact lenses,

9) Thermodynamics: first and second laws of thermodynamics, thermodynamics of living systems, information and the second law,

10) Heat and life: energy requirements of people, energy from food, regulation of body temperature, control of skin temperature, evaporation, resistance to cold,

11) Electricity: nervous system, electrical potential in the axon, action potential, synaptic transmission, electricity in plants, electricity in the bones, electric fish, heart as an electric device,

12) Optics: vision, nature of light, structure of the eye, accommodation, lens system of the eye, resolving power of the eye, corrective lenses,

13) Atomic physics: the atom, spectroscopy, quantum mechanics, electron microscope, X-rays, Computed Tomography, lasers,

14) Nuclear physics: the nucleus, magnetic resonance imaging, radiation therapy, food preservation by radiation, isotopic tracers, laws of physics and life.

TEACHING METHODS:

Lecture, biophysics laboratory

LEARNING OUTCOMES:

The student is able to describe the physical bases of the functioning of living organisms (K_W03, K_W08, K_W10), is able to explain the functioning of the basic systems of the human body in terms of physics (K_W03, K_W08, K_W10, K_W16). The student is aware of the limitations of the human and animal bodies following from the laws of physics (K_W03, K_W08). He or she is able to perform basic experiments of the biophysics laboratory (K_U02, K_U06).

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

Final test, the preparation of 4 laboratory reports

STUDENT WORKLOAD:

- Participation in the lectures – 30h
- Preparation for the lectures – 15h
- Participation in the laboratory – 15h
- Preparation for the laboratory – 15h

RECOMMENDED READING:

1. F. Jaroszyk, Biofizyka, Wydawnictwo Lekarskie PZWL, Poznań, 2008

OPTIONAL READING:

2. P. Davidovits, Physics in Biology and Medicine, Academic Press, New York, 2008

COMPUTER GRAPHICS

Course code: 6.9-WM-IB-P-30

Type of course: Compulsory

Language of instruction: Polish/English

Director of studies: Dr inż. Przemysław Jacewicz

Name of lecturer: Dr inż. Przemysław Jacewicz

Form of instruction	teaching hours per	teaching hours per	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	

COURSE AIMS:

To make students aware of contemporary computer graphics (CG) technology, including the CG applications and SDKs. Understanding of CG related terminology and basic functionalities of CG systems.

PREREQUISITES:

Introduction to computer science

COURSE CONTENTS:

Human factors. Visual perception. Creator and consumer of computer graphics content, CG models.

Introduction to computer graphics technologies. Input/Output devices. Color models. Digital images. Sample CG applications in education, entertainment, architecture, science and human care. Scientific visualization.

Raster graphics. Digital raster images. Preparation of raster images. Desk-Top Publishing and pre-press. Processing raster images.

Fractals in computer graphics, theory and applications.

Vector graphics. Computer graphics and vector models. Interpolation and interpolators. Hierarchical structure of graphics objects. Graphics rendering pipeline. 3D scene construction algorithms. Computer Aided Design. Manipulation of 3D vector objects, 3D scene representation, shading and shadows.

Photo-realistic techniques. Ray Tracing and Radiosity, Environmental Mapping and Image-Based Rendering. Stereoscopic rendering.

Review of available software tools for computer graphics.

METHODS OF EDUCATION:

Laboratory tasks are meant to be solved in a given time. All tasks cover design, creative use of digital media within the CG environments including CG applications and SDKs. Lecture is generally based on the given references, but it includes the most recent information form conferences and events related to CG.

LEARNING OUTCOMES:

Learning outcomes		**Field specific learning outcomes**
Technical	**Engineering**	
Image processing	Raster imaging	Knowledge of image processing algorithms, raster imaging and pre-press skills of image manipulation and enhancement. DTP skills.
Vector graphics	CAD design	Knowledge of 2D and 3D image models, creative skills. CAD skills.
Scientific visualization	Infographics and media design	Knowledge of infomation design and infographics. Visualisation skills.

Student has the following knowlege and competences	**Type of activity**	**Form of education**	**Output**	**Symbols of discipline specific learning outcomes**
The student has an elementary knowledge of computer design and operations, has an ordered knowledge of operational systems, technologies, protocols and services in computer networks.	Lecture Lab+ consulting	Discussion Examples	Project	T1A_W04 T1A_K02 T1A_W07
The student can select and use the specialistic informatic tools to solve engineering problems in numerical way, analyse results and present them graphically, also prepare documents and digital media.	Lab	Examples	Project	T1A_W07 T1A_U07
The student can communicate using various techniques in the professional community as well as in other communities.	Lecture+ consulting	Discussion Examples	Project	T1A_U02
The student can select and apply the appropriate computer applications to make calculations, simulation, design and verification of engineering solutions in the field of Biomedical Engineering.	Lecture Lab	Examples	Project	T1A_U07

VERIFICATION OF LEARNING OUTCOMES AND CONDITIONS OF CLASSIFICATION:

Lecture – classification based upon positive mark obtained during colloqium or exam in form suggested by the teacher.

Lab - classification based upon positive marks obtained during the course. Final mark is a weighted sum of all marks obtained for the given lab tasks.

STUDENT WORKLOAD:

15 two-hour labs, where students receive tasks to be done during the course, 15 two-hour lectures.

Consultations	*30 hrs lect, 30 hrs lab =*	*60h*
Preparation	*10 h*	
Literature research	*10h*	
Preparation of report	*10h*	
Tasks received during the labs that require additional time (writing code, rendering animation, etc.)	*25h*	
Preparation for colloqium or exam	*10h*	
	Total 125h = 5 ECTS	

RECOMMENDED READING:

1. Hearn. D, Baker D.: *Computer Graphics- C version*, Prentice Hall, 1997
2. Jankowski M.: *Elementy grafiki komputerowej*, WNT, 2006 (in Polish)

OPTIONAL READING:

3. Tomaszewska-Adamerek A., Zimek R.: *ABC grafiki komputerowej i obróbki zdjęć*, Helion, 2007 (in Polish)
4. Preparata P., Shamos N.: *Geometria obliczeniowa. Wprowadzenie*, Helion, 2003 (in Polish)
5. Flemming B., Dobbs D.: *Animacja cyfrowych twarzy*, Helion, 2002 (in Polish)

REMARKS:

Students uses at labs supplementary materials obtained from the teacher and from the inernet resources.

ENTREPRENEURSHIP AND QUALITY CONTROL

Course code: 6.9-WM-IB-P-59

Type of course: Optional

Language of instruction: Polish/English

Director of studies: Dr inż. Agnieszka Kaczmarek-Pawelska

Name of lecturer: Dr inż. Agnieszka Kaczmarek-Pawelska

Form of instruction	teaching hours per	teaching hours per	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	30	2	V	Grade	
Project	30	2		Grade	

COURSE AIMS:

Course has specific goals:

1. To familiarize students with the issues and challenges facing entrepreneurs in emerging markets
2. To provide an understanding of the human and organizational contexts in which young entrepreneur will be working and the skills he will need to be productive and successful
3. To explore how to put the scientific, technical and organizational knowledge learned at University to work in today organizations.

COURSE CONTENTS:

Abraham Maslow and his model of human needs. Quality of Life, Strategic Thinking about Problem Solving, Marketing as a method of Quality of Life creating by Worth Exchange. Marketing and Entrepreneurship, Identifying Market Opportunities, Market Development, Entrepreneurial Communication Strategy, Entrepreneurial Pricing Strategy, Entrepreneurial Distribution Strategy, Building Customer Relationships.

Management as; planning, organizing, staffing, motivating, directing and controlling. Productivity, Lean management, Total Quality Management, Leadership and Team building. Project Management, Quality Function Deployment (QFD). Doman's Rules of Quality, Elements of Law for entrepreneurship, Tax policy in Poland, Financing, Emerging markets, Trends of Development in Technology, Society of Future. Multi- culture Relations and Communication. Creativity, methods of creative thinking. Business Plan, Cash Flow, Payback of Innovation. How to start business. Decision Theory, Risk Management.

TEACHING METHODS:

Lecture and class discussion. Homework with Business Plan preparing. Reading.

LEARNING OUTCOMES:

In the field of technical sciences	Knowledge, skills, competence	Symbols of discipline specific learning outcomes
K_W23	The student has a specialistic knowledge in the field of the chosen studies specialization	T1A_W03, T1A_W04, T1A_W05, T1A_W06, T1A_W07, T1A_W08, T1A_W11
K_W13	The student has a basic knowledge necessary to understand the social, economic, legal, environmental and other non-technical considerations of engineering activities, understands the application of his/her knowledge in engineering practice, knows the rules associated with safety and ergonomics	T1A_W02 T1A_W07
K_U27	The student can use a specialistic knowledge to organize the implementation of simple tasks relevant to the field of the chosen specialization	T1A_U12, T1A_U13, T1A_U14, T1A_U15, T1A_U16
K_K06	The student can think and act in a creative and enterprising way	T1A_K06

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

The verification methods for learning outcomes are presented in the table below.

The reference to the learning outcomes of the field of study	The method of the learning outcomes assessment	Symbols of discipline specific learning outcomes
K_W13	The student has a basic knowledge necessary to understand the social, economic, legal, environmental and other non-technical considerations of engineering activities, understands the application of his/her knowledge in engineering practice, knows the rules associated with safety and ergonomics	T1A_W02 T1A_W07

K_W23	The student has a specialistic knowledge in the field of the chosen studies specialization	T1A_W03, T1A_W04, T1A_W05, T1A_W06, T1A_W07, T1A_W08, T1A_W11
K_U27	The student can use a specialistic knowledge to organize the implentation of simple tasks relevant to the field of the chosen specialization	T1A_U12, T1A_U13, T1A_U14, T1A_U15, T1A_U16
K_U06	The student can prepare and present an oral presentation concerning specific issues of the field of Biomedical Engineering	T1A_U04

End quiz for lecture and own made Project (Business plan) presentation evaluation

For note 3 - only basic, standard knowledge from lectures

For note 4 - knowledge from readings and own experience

For note 5 - own experience, readings, participation in class discussions, use of modern methods like QFD, Prince 2 etc.

STUDENT WORKLOAD:

Student workload is about 100 hours (4 ECTS) including prepare to lessons - 60 hours, 20 hours preparing to final presentation and 20 hours participating lessons

RECOMMENDED READING:

1. "The Essential Drucker" – Polish edition as „Myśli przewodnie Druckera", wyd.MT Biznes sp z o.o, 2001
2. "The Post Capitalist Society" – Peter Drucker, 1993, Polish edition as "Społeczeństwo pokapitalistyczne" Wyd. Naukowe PWN, Warszawa 1999
3. "The Toyota Way – 14 management principles from the world's greates manufacturer", Jeffrey K. Liker, by McGraw- Hill, 2004, Polish edition as "Droga Toyoty…" wyd. MT Biznes, 2005
4. "Future Shock" – Alvin Toffler, 1970, Polish edition as "Szok przyszłości" Wyd Zysk I S-ka, wyd. II 1974
5. "Kotler on Marketing. How to create, Win, and Dominate Markets", Philip Kotler, The Free Press, 1999, Polish edition as "Kotler o marketing, jak kreować I opanować rynki" Wyd. Profesjonalnej Szkoły Biznesu, Kraków, 1999
6. "Influence, Science and Practice" Robert B. Cialdini, A Pearson Educational Company, 2008, Polish edition as " Wywieranie wpływu na ludzi – teoria i praktyka" wyd. Gdańskie Wydawnictwo Psychologiczne, 2010

OPTIONAL READING:

7. „Biznes – po prostu" Leszek Czarnecki, Wyd. Studio EMKA, Warszawa, 2011
8. „Przedsiębiorczość dla ambitnych – jak uruchomić własny biznes" Jerzy Cieślik, Wyd. Akademickie i Profesjonalne, Warszawa 2006
9. „Happier: Learn the Secrets to Daily Joy and Lasting Fullfilment" – Tal Ben-Shahar, 2007, Polish edition "W stronę szcześcia", Wyd. Dom Wydawniczy REBIS 2009

HEAT ANF FLOW PROBLEMS IN BIOLOGICAL SYSTEMS

Course code: 6.9-WM-IB-P-51

Type of course: Compulsory

Language of instruction: Polish/English

Director of studies: Dr inż. Tomasz Klekiel

Name of lecturer: Dr inż. Agnieszka Mackiewicz

Form of instruction	teaching hours per	teaching hours per	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	30	2	V	Grade	
Laboratory	15	1		Grade	
Project	15	1		Grade	

COURSE AIMS:

Students are familiar to specific language of technical physic, methods of describing real processes, can create and use models of simple fluid flows and energy transformations. Students can solve simple technical problems in bio-engineering.

PREREQUISITES:

Course of BasicTechnical Physic

COURSE CONTENTS:

Scientific Methods of describing processes by physical units and Laws of Physics. The SI Units System. Dimensional Analysis. Properties of a Substance; ideal Gas, Mixtures of Gases. Equilibrium State of Matter. Motion, Forces, Energy, Conservation Lows for Matter and for Energy (Thermodynamics Lows). Practical Use of Matter and Energy Conservation Laws - D. Bernoulli Low for Fluids. Types of Processes, Spontaneous Processes. The Law of Entropy Creation. Changing Phases of a Pure Substance. Rheology, Surface Tension, Viscosity, Inertia Forces in Fluids. Navier – Stokes Equilibrium. Laminar and Turbulent Flows. Energy Transfer by Work, Heat, Radiation, Flow of Matter, Electrical Current. Mathematical Models of Energy transfer by Heat; Conduction, Convection, Radiation. Specific Properties of Biological Fluids; No-Newtonian

Flows, Pulsar Flows. Special cases of Heat Transfer and Flows in Bioengineering. Psychrometrics Effect, Friction Losses in Fluid Ducts, Technical Devices for Energy Treatment; Combustion, Refrigeration, Power Cycles, Heat Exchanger.

Project exercisers:

1. Systems of Units
2. Conservation Laws in Fluid Flows
3. Properties of Gases – Clapeyron`s Law
4. Heat Transfer
5. Energy Balance for some Processes
6. Molier Psychrometric Chart for Air Humidification
7. Combustion

Laboratory exercises:

1. Measure of Temperature
2. Measure of Pressure
3. Enthalpy of Combustion – Heating Value
4. Laminar and Turbulent Flow – visualization
5. Rheological Properties of Fluids
6. Heat Exchanger

LEARNING OUTCOMES:

Field specific learning outcomes	Knowledge, skills, competence
K_W23	The student has a specialistic knowledge in the field of the chosen studies specialization
K_U14	The student can select and apply the proper calculation methods to solve simple research problems in the field of Biomedical Engineering
K_U27	The student can use a specialistic knowledge to organize the implentation of simple tasks relevant to the field of the chosen specialization

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

The verification methods for learning outcomes are presented in the table below.

The reference to the learning outcomes of the field of study	The method of the learning outcomes assessment
K_W23	Credit based on written test. A passing grade in the lecture part of the course is determined by three written responses to questions about the theoretical aspects of the subject.
K_U14	Grade based on laboratory classes. A passing grade in laboratory part comprises positive evaluation of reports based on each laboratory class, attendance and initiative on the part of the student.

K_U27	Grade based on project. Grande on project is determined on the basis of accuracy of selection techniques and methods used and the quality of the project.

For grade course - lectures - Student must pass written quizze –enough 3 positive answers of 5 questions.

For Exercises – Student prepare correct written solution for given set of problems

For Laboratory – Grad by systematic Class participation

STUDENT WORKLOAD:

Student workload is about 100 hours (4 ECTS) including prepare to lessons - 60 hours, 20 hours preparing to exam and 20 hours participating lessons

RECOMMENDED READING:

1. Basic transport phenomena in biomedical engineering / Roland L. Fourier, 2 ed. New York, Francis Group, 2007
2. A Heat Transfer Textbook, 4th edition John H. Lienhard IV, Professor, University of Houston John H. Lienhard V, Professor, Massachusetts Institute of Technology
3. http://web.mit.edu/lienhard/www/ahtt.html

OPTIONAL READING:

4. http://ocw.mit.edu/resources/res-6-001-electromagnetic-fields-and-energy-spring-2008/
5. http://ocw.mit.edu/courses/biological-engineering/20-330j-fields-forces-and-flows-in-biological-systems-spring-2007/

IMPLANTS AND ARTIFICIAL ORGANS

Course code: 6.9-WM-IB-P-27

Course type: Compulsory

Language of instruction: Polish/English

Director of studies: Prof. dr hab. inż. Romuald Będziński

Name of lecturer: Prof. dr hab. inż. Romuald Będziński
Dr inż. Katarzyna Arkusz

Form of instruction	teaching hours per	teaching hours per	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					3
Lecture	30	2	VI	Grade	

COURSE AIMS:

Challenges and opportunities in replacing of failure organs by implants or artificial organs. Issue of organs and tissues transplantation. Significance of surgery techniques for saving patients health and life. Problems in implantology.

PREREQUISITES:

Basics: anatomy, physiology, immunology, pathophysiology, toxicology and chemistry.

COURSE CONTENTS:

Implant classification. Biomaterials/tissue interactions. Cellular response for implantation: inflammation, tissue repair process, biocompatibility with blood, carcinogenicity. Transplantology. Artificial organs. Biological effectors. Skeletal muscles control and stimulation. Active implants of motion organs. Stimulation and control the internal organs activities. External and implanted stimulators. Technical substitutes of organs. Biochemical effectors. Artificial tissues. Hematological and immunological problems in artificial organs. Heart stimulators. Heart-lung machine. Equipment for hemodialysis. Artificial pancreas (infusion pump+glucose sensor). Artificial liver. Artificial blood. Artificial skin.

TEACHING METHODS:

Audiovisual lectures, literature analysis, students presentations, meeting/lecture with surgeon.

LEARNING OUTCOMES:

Field specific learning outcomes	Knowledge, skills, competence
K_W02, K_W12	The student has knowledge in the field of medicine structure and organization, diagnostic and treatment methods, the basic anatomy, transplantation and implant techniques, needed to formulate and solve simple engineering tasks in Biomedical Engineering
K_U10	The student can use terminology relevant to the field of Biomedical Engineering
K_U06	The student can prepare and present an oral presentation concerning specific issues of the field of Biomedical Engineering

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

The reference to the learning outcomes of the field of study	The method of the learning outcomes assessment
K_W02, K_W12	Graduate – written verification of theoretical knowledge.
K_U06, K_U10	Verify of knowledge in students oral presentation concerning specific issues

STUDENT WORKLOAD:

The student workload of 75 hours (3 ECTS), including work in the auditorium 30 hours, preparing for grade 30 hours, literature analysis: 25 hours

RECOMENDED LITERATURE:

1. J Łaskawiec, R. Michalik Zagadnienia teoretyczne i aplikacyjne w implantach wyd. Polit. Śląska Gliwice 2002.
2. R. Tadeusiewicz Inżynieria biomedyczna wyd. AGH Kraków 2008.
3. Sztuczne narządy Tom3 red. M Dąbrowski , T. Orłowski.
4. Biomechanika Tom 5 Problemy Biocybernetyki i Inżynierii Biomedycznej.
5. H. Morawiec Z. Lekston Implanty medyczne z pamięcią kształtu. Wyd. Polit. Śląska Gliwice 2010.

MECHANICS AND STRENGTH OF MATERIALS

Course code: 6.9-WM-IB-P-22

Type of course: Compulsory

Language of instruction: Polish/English

Director of studies: Prof. dr hab. inż. Romuald Będziński

Name of lecturer: Prof. dr hab. inż. Romuald Będziński
Mgr inż. Ewa Paradowska

Form of instruction	teaching hours per	teaching hours per	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					5
Lecture	30	2	II	Exam	
Class	15	1		Grade	
Laboratory	15	1		Grade	

COURSE AIM:

The aim of the course is to familiarize students with problem-solving methodology based on the laws of mechanics and analysis of the strength found in mechanical engineering.

PREREQUISITES:

General knowledge of differential calculus, integral calculus, operations on the vectors.

COURSE CONTENTS:

Lecture

The basic notions and the principles of statics. Plane and spatial arrangement of convergent forces. Equilibrium plane and spatial arrangement of convergent forces. The basis of reduction of arrangement forces. The plane arrangements of strengths without friction (reduction of plane arrangement of forces, equilibrium of any plane arrangement of forces equilibrium of an arrangement consisting of rigid bodies). Friction and friction laws. Arbitrary spatial arrangement of forces. Reduction of spatial arrangement of forces. Basic notions of strength of materials. Objectives and tasks of the strength of materials. The types of loads. Types of deformations. Internal forces, de Saint Venant principle. Tension and compression of materials. Hooke's law, Young's modulus, Poisson's ratio. Principle of superposition, allowable stress, the safety factor. Statically determinate and statically

indeterminate systems tension or compression of rods systems. Analysis of stress and strain at the point, one-, two- and three-direction stresses and strains states. General components and main components of the stresses. Mohr's circle. Generalized Hooke's law for two- and three- direction stresses. Shear, strain and shear stress. Hooke's law in shear. Static moments. Moments of inertia of plane areas. Steiner formulae. Principal axes and principal moments of inertia, Mohr's circle for the moments of inertia. Torsion of circular shafts. Analysis of stresses and strains in torsion. Calculation of springs. Internal forces in rods and beams. Bending of straight rods.

Class

Solving classes based on lectures and source materials, in two parts: mechanics (vectors, constraints, reactions, coplanar forces: concurrent force systems, arbitrary force systems, determination of resultant moment, couples of forces, calculation of values of reactions in bearings of beams, calculation of internal forces in truss members of plane trusses) and strength of materials (tension, compression, shearing, bending, torsion).

Laboratory

Main topics: methods of measurement of hardness (Brinell, Rockwell and Vickers), static tensile metals, impact bending tests, determination of the static coefficient of friction, determination of the characteristics and stiffness of springs, dynamic balancing of machine parts with balancer.

TEACHING METHODS:

Lectures with audiovisual aids. Solving classes. Working with the book. Group work in laboratory classes.

LEARNING OUTCOMES:

Field specific learning outcomes	Knowledge, skills, competence
K_W08	The student has an elementary knowledge of engineering graphics, mechanics, the principles of workpiece design and mechanical equipment constructions, design of devices and production systems, as an engineering discipline relevant to the field of Biomedical Engineering
K_U02	The student can plan experiments and engineering activities, elaborate the results of testing and engineering tasks, draw conclusions, formulate and justify opinions in technical issues
K_U01	The student can obtain information from literature, databases and other sources, able to integrate the information, make their interpretation, as well as draw conclusions and formulate and opinions
K_K02	The student is aware of and understands the importance and impact of non-technical aspects of engineering, including its impact on the environment, and the responsibility for decisions consequently related with these aspects
K_K06	The student can think and act in a creative and enterprising way

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

The verification methods for learning outcomes are presented in the table below.

The reference to the learning outcomes of the field of study	The method of the learning outcomes assessment
K_W08; K_K02	Written exam. A passing grade in the lecture part of the course is determined by five written responses to questions about the theoretical aspects of the subject.
K_U01, K_K06	A passing grade in laboratory part comprises positive evaluation of reports based on each laboratory class, attendance and initiative on the part of the student.
K_U02	Positive evaluation of the test.

Lecture

Exam

Class

Grade

Laboratory

Grade (received positive ratings of reports carried out laboratory)

Evaluation of the course is getting positive ratings from all forms: Lecture, Class, Laboratory

The final grade received by the student is the arithmetic mean of the above grades.

STUDENT WORKLOAD:

The student workload is 127 hours (5 ECTS), including work in the auditorium: 60 hours, exam: 2 hours, consultations: 15 hours, preparing for classes: 25 hours, revising for exam 10 hours, revising for tests: 10 hours, preparing study reports 5 hours.

RECOMMENDED READING:

1. Niezgodziński M. E., Niezgodziński T., Wytrzymałość materiałów, 1979 PWN wyd. XI.
2. Misiak J., Mechanika ogólna – Statyka i kinematyka, 1993 WNT wydanie IV.
3. Misiak J., Zadania z mechaniki ogólnej. Statyka, 1994 WNT wydanie V.
4. Walicki E., Smak T., Falicki J., Mechanika. Wprowadzenie teoretyczne do laboratorium. 2005, Oficyna Wydawnicza Uniwersytetu Zielonogórskiego.
5. Walicki E., Smak T., Falicki J., Mechanika. Materiały pomocnicze do ćwiczeń laboratoryjnych. 2005, Oficyna Wydawnicza Uniwersytetu Zielonogórskiego.
6. Walicka A, Walicki E, Michalski D, Jurczak P, Falicki J., Wytrzymałość materiałów / T. 1: Podręcznik akademicki. Teoria, wzory i tablice do ćwiczeń laboratoryjnych. – Zielona Góra: Oficyna Wydawnicza Uniwersytetu Zielonogórskiego, 2008.

7. Walicka A, Walicki E, Michalski D, Jurczak P, Falicki J., Wytrzymałość materiałów T. 2: Ćwiczenia laboratoryjne – Materiały pomocnicze. - Zielona Góra: Oficyna Wydawnicza Uniwersytetu Zielonogórskiego, 2008.

OPTIONAL READING:

8. Rżysko J., Statyka i wytrzymałość materiałów , 1979 PWN.
9. Jakubowicz A., Orłoś Z., Wytrzymałość materiałów, 1984 WNT.
10. Gubrynowiczowa J., Wytrzymałość materiałów, 1968 PWN.
11. Leyko J., Mechanika ogólna. t. I, 1980 PWN wydanie VII.
12. Leyko J., Zbiór zadań z mechaniki ogólnej. t. I, 1978 PWN wydanie IV.
13. Banasiak M., Grossman K., Trombski M., Zbiór zadań z wytrzymałości materiałów, 1998, PWN.

TEST METHODS FOR BIOMATERIALS

Course code: 6.9-WM-IB-P-20

Type of course: Compulsory

Language of instruction: Polish/English

Director of studies: Dr inż. Agnieszka Kaczmarek-Pawelska

Name of lecturer: Dr inż. Agnieszka Kaczmarek-Pawelska
Mgr inż. Marta Nycz

Form of instruction	teaching hours per	teaching hours per	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	15	1	V	Exam	
Project	45	3		Grade	

COURSE AIMS:

The aim of the course is to acquire skills and competencies in the practical use of chemical and electrochemical methods of surface layer formation and instrumental testing methods of their properties and degradation in tissue environment.

PREREQUISITES:

Knowledge of chemistry, electrochemistry and biomaterials.

COURSE CONTENT:

Lecture and Laboratory: Electrochemical testing methods, formation conditions and properties of surface layer and degradation of biomaterials (corrosion testing of implants, electropolishing, passivation, anodizing, formation of nanostructured layers). *M*ethods of microstructural examinations *(*optical, scanning electron SEM and transmission TEM microscopy, X-ray diffraction XRD*)*. Properties of biomaterial/tissue interface *(*hydrophilic-hydrophobic properties, zeta potential, photoelectron spectroscopy: XPS, SIMS, atomic force microscopy – AFM, tunneling microscopy, infrared spectroscopy FTIR-ATR), testing of biomaterials in simulated biological environment, chemical investigation of extracts, degradation in vitro and in vivo tests. Procedures and standards of biomaterials engineering.

TEACHING METHODS:

Conventional lectures with audiovisual aids. Working with professional literature. Individual and team work on laboratory exercises.

LEARNING OUTCOMES:

Field specific learning outcomes	Knowledge, skills, competence
K_W23	The student has an elementary knowledge of basic methods and algorithms for testing biomaterials using electrochemical methods
K_W11	The student knows the basic method for selecting a set of analytical techniques to the study of biomaterials
K_U13	The student knows how to use the software used for electrochemical studies
K_U19	The student can analyze signals and interpret polarization characteristics
K_U24	The student is able to suggest improvements to existing technologies, is able to able to assess the usefulness of routine methods and techniques related to the scope of Biomedical Engineering
K_K02	The student is aware of the benefits of advanced polarization techniques and materials research in the field of medicine

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

The reference to the learning outcomes of the field of study	The method of the learning outcomes assessment
K_W11, K_W23	The written exam A passing grade in the lecture part of the course is determined by written responses to questions about the theoretical aspects of the subject.
K_U13, K_U19, K_U24, K_K02	Project: Grade Grade based on accuracy of selection techniques and methods the student uses and the quality of the project

Lecture: Exam

Laboratory: Grade

STUDENT WORKLOAD:

The student workload of 102 hours (4 ECTS), including work in the consultations: 60 hours, exam: 2 hours, preparing for grade: 20 hours, preparing a project: 15 hours, familiarization with literature sources: 5 hours.

RECOMMENDED READING:

1. Z. Galus „*Teoretyczne podstawy elektroanalizy chemicznej*”, PWN Warszawa 1977.
2. J. Koryta, J. Dvorak, V. Bohackowa, „*Elektrochemia*”, PWN, Warszawa 1980.
3. A.J.Bard, L.R. Faulkner, „*Electrochemical Methods*”, Wiley, New York 1980 (or later editions).
4. L. Dobrzański, A. Hajduczek, *Mikroskopia optyczna i elektronowa,* WNT, 1987.
5. A. Oleś, *Metody doświadczalne fizyki ciała stałego,* WNT, 1993.
6. J. Przedmojski, *Rentgenowskie metody badawcze w inżynierii materiałowej,* WNT 1990.
7. Z. Bojarski, E. Łągiewka, *Rentgenowska analiza strukturalna,* PWN 1988, Wyd. Joseph Wang, „Analytical Electrochemistry” 1994 VCH Publisher, Inc, New York, Cambridge.

NUMERICAL METHODS

Course code: 6.9-WM-IB-P-38

Type of course: Compulsory

Language of instruction: Polish/English

Director of studies: Dr inż. Tomasz Klekiel

Name of lecturer: Dr inż. Tomacz Klekiel

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

COURSE AIM:

• familiarize students with the basic aspects of numerical mathematics to solve common problems,

• familiarize students with the basic algorithms to solve these tasks,

• education students' ability to use Matlab to issues of engineering calculations.

ENTRY REQUIREMENTS:

Mastery of knowledge and skills in the subject Elements of Algebra and Mathematical Analysis

COURSE CONTENTS:

Lecture: Computer Arithmetic (Fixed and floating point representation of numbers, calculation errors in floating-point arithmetic and accuracy of numerical algorithms, numerical conditioning task). Solving nonlinear equations (bisection method, regulatory falsi, secant and tangent method). Solving linear algebra (exact method for solving systems of linear equations: Gauss method, pivoting, triangular distribution method, Thomas-Banachiewicz Cholesky method, iterative methods: Jordan, Gauss-Seidel, setting benchmarks and matrix inverse spectral problem). Interpolation (definition and classification methods, polynomial interpolation: Lagrange interpolation formula, Newton's interpolation formula, spline interpolation, splines 3 degrees). Approximation (mean square approximation discrete and continuous, triangular families of orthogonal polynomials in approximation). Quadrature (pattern of rectangles and triangles, Newton-Cotes quadrature, Gauss quadrature, numerical integration of the limits of improper integrals and singular points within the interval of integration, integration of

multidimensional functions). Ordinary differential equations (Euler's method, Runge-Kutta methods). Introduction to the methods of boundary and partial differential equations.

Laboratory: Environmental engineering calculations Matlab (system resources, environmental programming, graphical tools, and editing). Floating-point arithmetic (numerical experiments, errors of calculation procedures and the accumulation and transfer of numerical instability). Solving equations (equations of nonlinear systems of linear equations, systems of a van der Monde, testing algorithms, Newton and Newtona_Raphsona). Data Processing (interpolation method, method of approximation of mean method, spectral analysis, Fast Fourier Transform). Ordinary differential equations, initial and boundary issues. Elementary finite element techniques and testing them on the basis of certain issues.

TEACHING METHODS:

Lecture: Lecture conventional

Laboratory: laboratory exercises and accounting

LEARNING OUTCOMES:

Field specific learning outcomes	Knowledge, skills, competence
K_W05	Student who has completed the subject understands the limitations of numerical algorithms related to floating-point arithmetic.
K_W19	Knows the basic numerical methods for solving nonlinear equations and systems of linear equations and differential, know the basic techniques of interpolation, approximation and numerical integration.
K_U25	Able to take advantage of the functionality of MATLAB environment to basic numerical, graphical representation of the results.
K_U25	Able to choose of these algorithms which is the most advantageous to solve a specific numerical problem.

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

The reference to the effects of field of study	The method of checking the effect of education
K_W05, K_W19	Grading lecture The pass of the lecture is to provide a positive evaluation of the test.
K_U25	Grading of the laboratory Evaluation of the laboratory is based on checking student prepare for classes and their implementation, and reports / reports resulting from the implementation of all measures to be implemented exercise.

Learning outcomes 1 and 2: the final test to evaluate the content of the lecture; Learning outcomes 3 and 4: Final test for assessment based on problem-solving tasks using computer and Matlab environment.

STUDENT WORKLOAD:

The student workload is 100 hours (4 credits), including contact hours: 45 hours, 15 hours consultation, preparation for classes: 15 hours, preparing to test: 5 hours, preparation of audit work, reports, reports, etc.: 20 hours, familiarization with literature sources 15 hours.

RECOMMENDED READING:

1. Stachurski M., Metody Numeryczne w programie MATLAB. Wydawnictwo MIKOM Warszawa 2003.
2. Zalewski A.. Cegieła R., MATLAB – obliczenia numeryczne i ich zastosowania. Wydawnictwo Nakom. Poznań 2001.
3. Fortuna Z., Macukow B., Wąsowski J., Metody numeryczne. Warszawa: Wydawnictwa Naukowo-Techniczne, 1995.
4. Demidowicz B. P., Maron I. A., Metody numeryczne. Tom 1. Analiza, algebra, metody Monte Carlo. Warszawa: Państwowe Wydawnictwo Naukowe, 1965.
5. Demidowicz B. P., Maron I. A., Szkwałowa E. Z., Metody numeryczne. Tom 2. Przybliżanie funkcji: równania różniczkowe i całkowe. Warszawa:PWN, 1965.

OPTIONAL READING:

6. Baron B., Metody numeryczne w Turbo Pascalu: 3000 równań i wzorów. Gliwice: Helion, 1995.

PROGRAMMING LANGUAGES

Course code: 6.9-WM-IB-P-32

Type of course: Compulsory

Language of instruction: Polish/English

Director of studies: Dr inż. Katarzyna Arkusz

Name of lecturer: Dr inż. Katarzyna Arkusz

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

COURSE AIM:

The aim is to acquire the skills and competencies of the structured programming in C language and the basics of programming in C + +

ENTRY REQUIREMENTS:

Basic knowledge of information technology.

COURSE CONTENTS:

Designing the program. Structured Programming. The algorithms and data structures and their representations in a programming language. Programming in C. The structure of the program, the command syntax. Fixed and variable data types. Operators, expressions. Type conversions. Arithmetic operators and their hierarchy. Instructions inputs and outputs. Conditional statements. Instructions iterative loops: for, while, for. Features: structure, arguments, result, prototype declaration calling. The formal parameters and actual functions. The concept and properties of the stack. Passing parameters by value and address. Returning values from functions. Recursive functions.

Indicators: declaration, initialization, and a reference to the address indicated value. Solid indicators and indices for fixed: properties and application range. Pointers to functions: examples of applications. Formal parameters of the function which is a pointer to a function.

Boards. The declaration, applicable examples. String as an array of characters. Arrays vs pointers. Multi-dimensional arrays. Data structures. Properties. Arrays of structures. Fields. Lift.

Introduction to object-oriented programming. The concept of class as an abstract data type, storage methods, encapsulation. Basics of inheritance. Polymorphism as a mechanism to support object-oriented programming.

TEACHING METHODS:

Lecture: Lecture in the form of a multimedia presentation
Laboratory: Exercises and calculations

LEARNING OUTCOMES:

Field specific learning outcomes	Knowledge, skills, competence
K_W07	Has ordered knowledge of the methods and techniques of programming.
K_U17	Able to formulating and solving tasks related to biomedical engineering, to see the system aspects, economic, legal and social with the use of computer technology.

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

The reference to the effects of field of study	The method of checking the effect of education
K_W07	Grading lecture The pass of the lecture is to provide a positive evaluation of the test.
K_U17	Grading of the laboratory Evaluation of the laboratory is based on checking student prepare for classes and their implementation, and reports / reports resulting from the implementation of all measures to be implemented exercise.

Lecture - provided credit is to get a positive evaluation of the test.
Laboratory - provided credit is to pass all the laboratory.

STUDENT WORKLOAD:

The student workload is 100 hours (4 credits), including contact hours: 60 hours, preparation for classes: 20 hours, preparing for test: 10 hours, sources familiar with the literature: 10 hours

RECOMMENDED READING:

1. Loudon K. Algorytmy w C. Helion 2003.
2. Kerighan, R. Programowanie w języku C. WNT 2000.
3. Kisilewicz J. Język. w środowisku Borland C++. Wydanie IV. Oficyna Wydawnicza Politechniki Wrocławskiej. Wrocław 2003.

4. Stroustrup B. C++ Język programowania. WNT 2001.

OPTIONAL READING:

5. Lippman S.B. *Model w C++*, WNT, Warszawa, 1996.
6. Eckel B. *Thinking in C++*, Hellion, Warszawa, 2002.

MOBILITY REHABILITATION

Course code: 6.9-WM-IB-P-57

Type of course: Compulsory

Language of instruction: Polish/English

Director of studies: Dr inż. Tomasz Klekiel

Name of lecturer: Dr inż. Tomasz Klekiel

Form of instruction	teaching hours per	teaching hours per	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	30	2	VI	Exam	
Project	30	2		Grade	

COURSE AIM:

The aim of the course is presentation the basics of rehabilitation engineering in designing of medical equipment, rehabilitation devices and basic methods of rehabilitation.

ENTRY REQUIREMENTS:

Introduction to Medical Science, Physiology and Anatomy, Physics, Mechanics, Electronics and Electrical Engineering, Computer Aided Design, Biomechanics, Sensors and Measurement of Non-electrical Signals, Electronic Medical Equipment.

COURSE CONTENTS:

Lecture: Introduction to rehabilitation engineering, history of rehabilitation, basic definitions,, the phase of the rehabilitation process. The role of rehabilitation engineering, upper limb prosthesis, prosthetic hand, forearm prosthesis, prosthetic legs, gait kinematics, locomotion, prosthetic legs, prosthetic feet, prosthetic dynamic foot, lower leg prosthesis, prosthetic thigh, hip prostheses, legs orthotics, limbs orthotics. Functional stimulation of the lower limbs, functional electrical stimulation, supply orthotic upper limbs, upper limbs orthosis, spine orthotics equipment, aids, Sensor technology in the devices for rehabilitation, rehabilitation devices, measurements of muscle tension, non-electrical measurements in medical diagnostics, sensors in modern prosthetics and orthotics. Innovative solutions smart rehabilitation devices.

Project: An introduction to rehabilitation engineering, analysis methods and techniques for rehabilitation of the locomotion system selected, the principles of the planning process of rehabilitation, medical consultation, conceptual design of mechatronic devices supporting the rehabilitation process of a particular condition, the assessment of solutions in terms of the effectiveness of the rehabilitation process, the technical capabilities of the device, the conditions and rules for the production of medical and rehabilitation equipment, machine control system design, selection of actuators and sensors, preparation of technical

documentation, assembly drawing machine, drawings, control algorithms, evaluation of projects.

TEACHING METHODS:

Lecture conventional design method, discussion, work with the literature, group work.

LEARNING OUTCOMES:

Field specific learning outcomes	Knowledge, skills, competence
K_W23	Knows the basic equipment used in the process of rehabilitation, has a basic knowledge of the development of modern techniques of rehabilitation, has information in the field of rehabilitation equipment recycling, and has a basic knowledge of the problems of people with disabilities
K_U05	has the ability to organize work in a project team
K_U18	Apply principles of safety rehabilitation equipment and prosthetic devices
K_U20	Able to choose a design solution in terms of cost performance, formulate a conceptual design for the chosen design of rehabilitation equipment and in accordance with a preset specification, taking into account the non-technical aspects of the design a simple device for rehabilitation
K_U24	Able to identify the device by its purpose, on the basis of knowledge and analysis of the functioning and indicate a device which assists the rehabilitation of selected diseases
K_U27	Able to find and discuss the principle of rehabilitation equipment for the assumed purpose and also has experience in the analysis of the relationship between structural and functional solution rehabilitation equipment
K_K01, K_K02 K_K03	Has knowledge of the importance of technical measures in the lives of people with disabilities, acquire skills and experience in teamwork and is aware of the ongoing development of rehabilitation equipment and prosthetic devices

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

The reference to the effects of field of study	The method of checking the effect of education
K_W23	Grading lecture – exam The pass of the lecture is to provide a positive assessment of written responses to questions regarding the theoretical issues of the subject.
K_U05, K_U18, K_U20,	Grading project classes Evaluation of the project is determined on the basis of the relevance of selection techniques and methods used and the quality of the

K_U27	implementation of the project.
K_K01, K_K02, K_K03	Skills developed during the project and its various stages of consultation.

Lecture: The prerequisite is to obtain a positive evaluation of the test carried out in writing form.

Project: credit with a grade (based on credit ratings received during the project's preparation for classes, and the final assessment for the project).

The final grade is the average of all ratings.

STUDENT WORKLOAD:

The student workload is 100 hours (4 ECTS), including contact hours: 60 hours exam: 2 hours, preparation for classes: 8 hours, the development of the project: 20 hours, to prepare for the exam: 10 hours.

RECOMMENDED READING:

1. Biomechanika i Inżynieria Rehabilitacji, Tom 5.
2. T. Bober, J. Zawadzki, Biomechanika układu ruchu człowieka.
3. Ross Ethier, Craig A. Simmons, Introductory Biomechanics.
4. Romuald Będziński, Biomechanika Inżynierska, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 1997.
5. Kolster, G. Ebelt-Paprotny Poradnik fizjoterapeuty, Osolineum, 1996.
6. Borkowska M. (red): ABC rehabilitacji dzieci. Najczęstsze schorzenia narządu ruchu. Wyd. Pelikan, Warszawa 1989.
7. Bruhl W. : Zarys reumatologii. PZWL, Warszawa 1987.
8. Dega., Senger A.: Ortopedia i rehabilitacja. PZWL, Warszawa 1996.

OPTIONAL READING:

9. Dega W., Milanowska K.: Rehabilitacja medyczna. PZWL, Warszawa 1993.
10. Dziak A.: Ćwiczenia usprawniające w uszkodzeniach kości i stawów. PZWL, Warszawa 1990.
11. Encyklopedyczny Słownik Rehabilitacji, 1986.
12. Grochmal S., Zielińska- Chrzanowska S.: Rehabilitacja w chorobach układu nerwowego. PZWL, Warszawa 1986.
13. Hulek A.: Człowiek niepełnosprawny w społeczeństwie. PZWL, Warszawa 1986.
14. Kaliszewski J.: Rehabilitacja w klinice chorób wewnętrznych.PZWL, Warszawa 1974.
15. KiwerskiJ., Kowalski M., Krasuski M.: Schorzenia i urazy kręgosłupa. PZWL, Warszawa 1997.
16. Kuch J.: Rehabilitacja. PZWL, Warszawa 1989.
17. Larkowa H.: Człowiek niepełnosprawny – problemy psychologiczne. PWN, Warszawa 1987.
18. Larkowa H.: Postawy otoczenia wobec osób niepełnosprawnych. PZWL, Warszawa 1970.

SENSORS AND NON-ELECTRICAL QUANTITIES MEASUREMENT

Course code: 6.9-WM-IB-P-45

Course type: Optional

Language: Polish/English

Main lecturer: Dr. hab. inż. Wiesław Miczulski, prof. UZ
Dr. inż. Katarzyna Arkusz

Second lecturer: Dr inż. Mariusz Krajewski

Lecture form	All lectures time	Lecture time in one week	semester	Form of graduation	ECTS points
Stationary studies					3
Lecture	30	2	IV	Grade	
Laboratory	30	2		Grade	

CEL PRZEDMIOTU:

The aim of the course is acquisition knowledge and competences in practical use and exploitation of sensors and to measure non-electrical quantities in biomedical engineering.

REQUIRED BASE:

Basics: electrotechnics, electronics, physics, biology, biochemistry, metrology.

COURSE CONTENTS:

Course includes:

Lectures: Introduction to measurements of non-electric quantities. Examples of non-electrical sensors in medicine. Energy transfer in sensors. Static and dynamic properties of sensors. Intelligent sensors. Sensor networks. Temperature measurements. Measurements of selected mechanical values. Tensometric sensors of strength and pressure in medicine. Flow and vibration measurements and their examples in medicine. Magnetic field in medicine. Sound sensors. Microphone and their examples in medicine. Photo electric sensors. Semiconductor light sources. Semiconductor light sensors. Photo electric sensors in oximetry. Measurements of selected physical values. Humidity measurements. Density measurements. Viscosity measurements. Measurements of hydrogen ions concentration (pH). Absorption spectrometry, mass spectrometry, surface absorption. Liquid and gas chromatography. Basics of polarography and voltametry. Characteristics of selected polarography techniques. Introduction to biosensors. Medical and non-medical applications. Transmitter systems. Immunosensors. Biopotentials, microelectrodes, electrical phenomena of electrode-tissue interaction. Biomolecules and analytes, proteins, antibodies and nucleic acids, biomolecules immobilization, receptors and cells biosensors. Materials and preparation techniques. Electrochemical biosensors. Redox enzymes and

mediators first, second and third generation. Cyclic voltametry, amperometry, potentiometry. Lab-on-a-chip, dry biotests, bioreactors, non-medical biosensors applications (in environmental protection, food industry). Developments in biosensors (implanted, miniaturized)

Laboratory: Extensometers and linear shift sensors. Temperature sensors. Magnetic field sensors. Pressure and humidity sensors. Analog- to- digital transducers. Viscosity measurements. Electrochemical measurements- volt amperometry. Ions concentration measurements due to different ions selected electrodes. Conductivity measurements. Spectrophotometry measurements.

TEACHING METHODS:

Lecture: Audiovisual lectures, literature analysis

Laboratory: Practical exercises (individual or in student group)

LEARNING OUTCOMES:

Field specific learning outcomes	Knowledge, skills, competence
K_W06	The student has an ordered and theoretically based knowledge of sensors, biosensors and other actuators of electrical and non-electrical quantities - applied in medicine, has basic knowledge of scientific results elaboration, knows the basic diagnostic methods and tools as an engineering discipline relevant to the field of Biomedical Engineering
K_W17	The student has an ordered knowledge of signals theory, in particular methods of signal filtration and digital signal processing
K_U04, K_U13	The student can use known analytical, simulation and experimental methods to undertake decisions in the field of Biomedical Engineering
K_U06, K_U19	The student can plan and carry out experiments, including measurements and computer simulations, to interpret the results and draw conclusions
K_K02	The student is aware of and understands the importance and impact of non-technical aspects of engineering, including its impact on the environment, and the responsibility for decisions consequently related with these aspects

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

The reference to the learning outcomes of the field of study	The method of the learning outcomes assessment
K_W06, K_W17	Written exam – verification of theoretical knowledge
K_U04, K_U06, K_U13, K_U19,	Practical verification of knowledge and skills in sensors and measurements of non-electrical quantities. Written report from every

K_K02	exercise with data presentation and conclusions.

Lectures: Grade

Seminar: Grade

STUDENT WORKLOAD:

The student workload of 75 hours (3 ECTS), including work in the auditorium 60 hours, preparing for grade 5 hours, preparing of control work and reports 5 hours, preparing for classes 5 hours.

RECOMENDED LITERATURE:

1. Miłek M.: Metrologia elektryczna wielkości nieelektrycznych. Wydawnictwo Uniwersytetu Zielonogórskiego, Zielona Góra 2006.
2. Piotrowski J. (red.): Pomiary czujniki i metody pomiarowe wybranych wielkości fizycznych i składu chemicznego. WNT, Warszawa 2009
3. Szczepaniak W.: Metody instrumentalne w analizie chemicznej. PWN, Warszawa 2008.
4. Torbicz W. i inni: Biopomiary, t.2 serii Biocybernetyka i inżynieria biomedyczna pod red. Macieja Nałęcza. Akademicka Oficyna Wydawnicza EXIT, 2001.
5. Bharat Bhushan (ed.), Springer handbook of nanotechnology, Springer - Verlag, 2004.
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