ErgoDesign

Improving digital skills for Ergonomics and Bioengineering Innovations for inclusive Health Care

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PR2: ErgoDesign Course Curriculum Framework

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1. ErgoDesign Training Course

1.1 Objective of training course

is to train a new generation of medical and technical staff to be able to boost the innovation in the medical plants sector to answer an unsolved social issue related to the requirements of people with special needs (physical or mental diseases) that are prevented from accessing cures due to their disabilities

1.2 Target groups for training

- bioengineering students
- medical staff
- technical staff

1.3 Needs analysis consultation on training

The starting point for the training course curriculum development was the Delphi study which allow to verify the true training needs in the specific area.

Six basic topic areas:

1. Biomaterials and their processing technologies SCORE: 3.86

2. Design, imaging and digital support for medical device design SCORE: 3.87

3. IT solutions in medicine SCORE: 3.77

4. Basic medical issues SCORE: 3.68

5. Medical & hospital equipment SCORE: 3.75

6. Soft skills & management & ergonomics in relation to requirements of people with special needs SCORE: 3.76

Biomaterials and their processing technologies

SCORE: 3.86
This section includes:
- 3D printing
- materials and biomaterials
- machining, plastic forming, casting
- heat treatment, thermo-chemical treatment, corrosion and protection
- selection of materials
- materials for prostheses, orthoses, implants, etc.
- biocompatibility and biodegradation issues

Statement: 18 (1st round)
Content: Interaction of biomaterials with the human body, inflammation, trauma, infections, physiology, biomechanics, bioelectric phenomena, tissue engineering, cardiovascular models should be integrated in a programme content.
Score: 3.87

Statement: 22 (1st round)
Content: Basic function and performance of passive and active implant materials should be integrated in a programme content.
Score: 3.97

Statement: 21 (1st round)
Content: Selection of biomaterials based on function, biological environments, toxicity and economic aspects should be integrated in a programme content.
Score: 3.90

Statement: 17 (1st round)
Content: Biomaterials in biomedical applications should be integrated in a programme content.
Score: 3.88

Statement: 19 (1st round)
Content: Mechanical properties of materials should be integrated in a programme content.
Score: 3.88

Statement: 9 (1st round)

Content: Basic types of 3D modelling (wireframe, solid, surface, mesh) should be integrated in practical activities.
Score: 3.93

Statement: 23 (1st round)
Content: Corrosion and degradation mechanisms of biomaterials in different applications should be integrated in a programme content.
Score: 3.77

Statement: 20 (1st round)
Content: Physical, chemical and mechanical aspects of bulk and surface properties of metallic, polymer and ceramic biomaterials should be integrated in a programme content.
Score: 3.79

Statement: 16 (1st round)
Content: Interaction of biomaterials with biological tissues and biological fluids should be integrated in a programme content.
Score: 3.80

Design, imaging and digital support for medical device design

SCORE: 3.87

This section includes:

- CAD
- CAx (CAM, CAE)
- 3D scanning
- Medical Imaging (CT/MRI/USG)
- Biomechanics + biomechanical design
- Medical device design - assumptions, requirements, etc.
- Design: endoprostheses, rehabilitation equipment, implants, etc.

Statement: 14 (1st round)
Content: Biomechanical applications in human movement should be integrated in a programme content.
Score: 3.97

Statement: 42 (1st round)
Content: Methodologies of design and production of personalized implants and endoprostheses basing on medical imaging data and additive manufacturing technologies should be integrated in a programme content.
Score: 4.00

Statement: 38 (1st round)
Content: Technologies of rapid manufacturing and rapid prototyping of personalized medical devices (including, but not limited to 3D printing processes) should be integrated in a programme content.
Score: 4.00

Statement: 39 (1st round)
Content: As an outcome of studies, graduates should be able to utilize any source of medical 3D data to digitally design a personalized medical device (e.g. an implant or a prosthesis).
Score: 3.97

Statement: 34 (1st round)

Content: Technologies for measurement of motion kinematics: interfacing features; sensors; information recognition and extraction; signal processors; noise identification and suppression; off-line and real time tracking; calibration and 3D reconstruction should be integrated in a programme content.
Score: 3.97

Statement: 40 (1st round)
Content: Principles of design, material selection and production of personalized implants and endoprostheses should be integrated in a programme content.
Score: 3.97

Statement: 8 (1st round)
Content: Intelligent (automated) computer aided design models in medicine should be integrated in practical activities.
Score: 3.97

Statement: 36 (1st round)
Content: Technologies of additive (layered) manufacturing of organic shapes (also known as 3D printing) should be integrated in a programme content.
Score: 3.91

Statement: 41 (1st round)
Content: Principles of design, material selection, production and programming of personalized artificial organs (such as hearing implants or cardiac implants) should be integrated in a programme content.
Score: 3.92

Statement: 35 (1st round)
Content: Human motor behaviour simulation and virtualization; human body modelling; application of captured human motion data to virtual models and scene to simulate interaction should be integrated in a programme content.
Score: 3.92

Statement: 4 (1st round)
Content: Contactless measurement techniques for anthropometric data gathering (such as 3D scanning, photogrammetry etc.) should be integrated in a programme content.
Score: 4.11

Statement: 7 (1st round)

Content: Kinematics and kinetics of movement and muscle force system in a programme content.
Score: 3.93

Statement: 10 (1st round)
Content: Both freeware and commercial CAD software should be considered for use during the classes
Score: 3.97

Statement: 34 (1st round)
Content: Graphics design and UX design for medical software applications should be integrated in practical activities.
Score: 3.81

Statement: 32 (1st round)
Content: Hybrid 3D modelling techniques of anatomical shapes in advanced CAD systems should be integrated in practical activities.
Score: 3.78

Statement: 50 (1st round)
Content: Future possibilities, development trends and potential, but not yet available solutions in personalized implants and artificial implants should be discussed with students and integrated in a programme content.
Score: 3.65

Statement: 33 (1st round)
Content: Applications of advanced dynamic simulation systems (e.g. fluid dynamics, thermodynamics) in medical context should be integrated in practical activities.
Score: 3.74

Statement: 6 (2nd round)
Content: Force systems, resultant, equalities, equilibrium, planar force systems, internal forces and moments, internal force diagrams and problems including friction should be integrated in a programme content.
Score: 4.23
Statement: 6 (1st round)
Content: Force systems, resultant, equalities, equilibrium, planar force systems, internal forces and moments, internal force diagrams and problems including friction should be integrated in a programme content.
Score: 3.73

Statement: 45 (2nd round)
Content: Design solutions and principles of work of advanced bionic upper limb prosthetics should be integrated in a programme content.
Score: 3.86
Statement: 45 (1st round)
Content: Design solutions and principles of work of advanced bionic upper limb prosthetics should be integrated in a programme content.
Score: 3.71

Joint into one (27, 20, 10 and 1):
Statement: 27
Content: CAx (CAD/CAM/CAE) software is very important part of bioengineering course and should not be limited to just the basics.
Score: 3.93

Statement: 20 (2nd round)
Content: CAM software for planning of various manufacturing processes should be integrated in practical activities.
Score: 4.15
Statement: 20 (1st round)
Content: CAM software for planning of various manufacturing processes should be integrated in practical activities.
Score: 3.65

Statement: 1 (2nd round)
Content: It is important to familiarize the bioengineering students with as much various specialized software as possible, even at the cost of limited hours spent per one software package.
Score: 3.64
Statement: 1 (1st round)
Content: It is important to familiarize the bioengineering students with as much various specialized software as possible, even at the cost of limited hours spent per one software package.
Score: 3.38

Statement: 26 (2nd round)
Content: Use of mesh processing software joined with haptic manipulators for design of personalized implants should be integrated in practical activities.
Score: 4.08

Statement: 26 (1st round)
Content: Use of mesh processing software joined with haptic manipulators for design of personalized implants should be integrated in practical activities.
Score: 3.80

Statement: 2 (2nd round)
Content: In learning of 3D anatomical data processing and design of medical devices, project method and group work is more important than laboratory exercises.
Score: 3.85
Statement: 2 (1st round)
Content: In learning of 3D anatomical data processing and design of medical devices, project method and group work is more important than laboratory exercises.
Score: 3.34

Statement: 21 (1st round)
Content: Basic principles of Computer Aided Engineering (CAE) applications for medical devices, including Finite Element Analysis, should be integrated in practical activities.
Score: 3.84

Statement: 15 (1st round)
Content: Basic concepts on solids mechanics should be integrated in a programme content.
Score: 3.85

Statement: 18 (1st round)
Content: Advanced 3D parametric surface modelling over reverse-engineered 3D data (of medical imaging or 3D scanning) should be integrated in practical activities.
Score: 3.86

Statement: 28 (1st round)
Content: Basic principles of biomedicine, electronics and measurements with emphasis on operational characteristics and the selection of the inverters, instruments and systems for the collection and processing of biomedical data should be integrated in a programme content.
Score: 3.86

Statement: 4 (1st round)
Content: Software to analyze the scan of a healthy arm / leg of a patient with an arm / leg after injury should be integrated in practical activities.
Score: 3.87

Statement: 12 (1st round)
Content: Kinematics, dynamics and energetic aspects of human movement using biomechanical models should be integrated in a programme content.
Score: 3.94

Statement: 37 (1st round)
Content: Technologies of 3D bioprinting of organic tissues and hydrogels should be integrated in a programme content.
Score: 3.90

Statement: 39 (1st round)
Content: Medical imaging technologies (such as computed tomography, magnetic resonance imaging and ultrasound examination) should be integrated in a programme content.
Score: 3.97

Statement: 3 (1st round)
Content: Orthosis/prosthesis modeling software should be integrated in practical activities.
Score: 4.03

IT solutions in medicine

SCORE: 3.77

This section includes:

- VR/AR
- AI
- Telemedicine systems
- Medical Informatics
- Programming, etc.
- Databases

Statement: 12 (1st round)
Content: Algorithms of automation of processing of medical data should be integrated in practical activities.
Score: 3.97

Statement: 36 (1st round)
Content: Software tools for visualization of medical data should be integrated in practical activities.
Score: 4.02

Statement: 26 (1st round)
Content: Software to analyze the mechanics of movement from real measurements in a biomechanical laboratory should be integrated in a programme content.
Score: 3.97

Statement: 9 (1st round)
Content: Fundamental mathematical models in medical simulations should be integrated in a programme content.
Score: 3.93

Statement: 28 (1st round)
Content: Basic courses in popular programming languages (C#, Python, Java and others) should be integrated in practical activities.
Score: 3.82

Statement: 10 (1st round)
Content: Bioinformatics principles should be integrated in a programme content.
Score: 3.87

Statement: 11 (1st round)
Content: Computational methods in biomedical technology using finite elements should be integrated in a programme content.
Score: 3.89

Statement: 19 (1st round)
Content: Telemedicine, telediagnostics and telesurgery software should be included in practical activities
Score: 3.75

Statement: 29 (1st round)
Content: Devices, recording biosignal of (pressure, flow, bioelectric dynamics, temperature), and amplifiers should be integrated in a programme content.
Score: 3.80

Statement: 7 (1st round)
Content: Registration and operation of medical equipment, to evaluate cases of failure and to create concepts of preventative measures against these failures should be integrated in practical activities.
Score: 3.78

Statement: 32 (1st round)
Content: Technologies for measuring myoelectric activity: signal generation; electrodes; biological and environmental noise; amplifiers; sources of signal distortion should be integrated in a programme content.
Score: 3.78

Statement: 33 (1st round)
Content: Technologies for measuring forces exchanged between the subject and the environment: sensors and signal conditioning units; amplifiers; pressure maps; sources of signal distortions should be integrated in a programme content.
Score: 3.80

Statement: 22 (1st round)
Content: Programming of augmented and mixed reality applications used in medicine should be integrated in practical activities.

Score: 3.72

Statement: 23 (2nd round)
Content: Programming of augmented and mixed reality applications used in medicine should be integrated in practical activities.
Score: 3.85
Statement: 23 (1st round)
Content: Programming of augmented and mixed reality applications used in medicine should be integrated in practical activities.
Score: 3.66

Statement: 29 (2nd round)
Content: Students should learn creating and programming advanced databases in the medical and bioengineering context.
Score: 3.77
Statement: 29 (1st round)
Content: Students should learn creating and programming advanced databases in the medical and bioengineering context.
Score: 3.67

Statement: 30 (2nd round)
Content: Principles of building and programming interactive websites using PHP and other web technologies, in the medical context, should be integrated in practical activities.
Score: 3.31
Statement: 30 (1st round)
Content: Principles of building and programming interactive websites using PHP and other web technologies, in the medical context, should be integrated in practical activities.
Score: 3.50

Statement: 31 (2nd round)
Content: Advanced use of MS Excel, including macro programming in VBA language, in the medical and bioengineering context, should be integrated in practical activities.
Score: 3.46
Statement: 31 (1st round)
Content: Advanced use of MS Excel, including macro programming in VBA language, in the medical and bioengineering context, should be integrated in practical activities.
Score: 3.60

Statement: 38 (2nd round)

Content: As an outcome of studies, graduates should have skills in programming allowing them to create their own software applications for medical use.
Score: 3.71

Statement: 38 (1st round)
Content: As an outcome of studies, graduates should have skills in programming allowing them to create their own software applications for medical use.
Score: 3.70

Statement: 14 (1st round)
Content: Technologies for affordable and high-speed connectivity for patient data exchange should be integrated in practical activities.
Score: 3.72

Statement: 35 (1st round)
Content: Nature inspired artificial intelligence algorithms should be integrated in practical activities.
Score: 3.80

Statement: 2 (1st round)
Content: Software for medical devices, which will be integrated in a programme content, should be in the native language.
Score: 3.71

Statement: 8 (1st round)
Content: Knowledge engineering and expert systems should be integrated in a programme content.
Score: 4.07

Basic medical issues

SCORE: 3.68

This section includes:

- Anatomy
- Physiology
- Diagnostic and treatment methods
- Pharmacy
- Surgery, orthopedics, dentistry, etc.

Statement: 26 (1st round)
Content: Principles of design and operation of sensors should be integrated in a programme content
Score: 3.89

Statement: 2(1st round)
Content: Fundamental topics of muscle anatomy, physiology and treatment, and muscle modeling should be integrated in a programme content.
Score: 3.93

Statement: 30 (2nd round)
Content: Biomimetics and construction of biomimetic medical devices should be integrated in a programme content
Score: 3.85
Statement: 30 (1st round)
Content: Biomimetics and construction of biomimetic medical devices should be integrated in a programme content
Score: 3.57

Statement: 46 (2nd round)
Content: Knowledge about organ transplantation methods, techniques and restrictions should be integrated in a programme content.
Score: 3.23
Statement: 46 (1st round)
Content: Knowledge about organ transplantation methods, techniques and restrictions should be integrated in a programme content.

Score: 3.47

Statement: 48 (2nd round)
Content: Basic principles of operation and applications of pharmaceutical (drug) implants should be integrated in a programme content.
Score: 3.15

Statement: 48 (1st round)
Content: Basic principles of operation and applications of pharmaceutical (drug) implants should be integrated in a programme content.
Score: 3.29

Statement: 47 (1st round)
Content: Basic principles of work of electronic implants should be integrated in a programme content.
Score: 3.69

Statement: 49 (1st round)
Content: Surgical and general medical requirements and restrictions concerning personalized implants and endoprostheses should be integrated in a programme content.
Score: 3.69

Statement: 13 (1st round)
Content: Information and communication technologies applications for innovative solutions in dentistry should be integrated in practical activities.
Score: 3.80

Statement: 13 (1st round)
Content: Biomechanical models of the musculoskeletal system based on the anthropometry of the human body and the mechanical laws of movement should be integrated in a programme content.
Score: 3.82

Statement: 5 (1st round)
Content: Mechanical behavior of biological tissues and systems should be integrated in a programme content.
Score: 3.82

Statement: 51 (1st round)

Content: Principles of conducting clinical studies of medical products should be integrated in a programme content.
Score: 3.81
Statement: 52 (1st round)
Content: Medical standards and rules of certification of medical products should be integrated in a programme content.
Score: 4.06

Statement: 31 (1st round)
Content: Medical device regulations should be integrated in a programme content.
Score: 3.83

Medical equipment, hospital equipment

SCORE: 3.75

This section includes:

- design of hospital premises
- medical robots
- operating rooms
- patient handling equipment
- etc.

Statement: 25 (1st round)
Content: Principles of design and operation of medical equipment should be integrated in a programme content.
Score: 3.95

Statement: 6 (1st round)
Content: Operation, inspection and maintainance of diagnostic and therapeutic equipment and software within the healthcare facility, including assistance to physicians during the examination of patients should be integrated in in practical activities.
Score: 3.86

Statement: 43 (1st round)
Content: Basic principles of operation of medical (surgical) robots should be integrated in a programme content.
Score: 3.72

Statement: 1 (1st round)
Content: Both knowledge of software and hardware should be integrated in practical activities.
Score: 4.22

Statement: 44 (2nd round)
Content: Basic principles of operation of industrial robots should be integrated in a programme content
Score: 3.71
Statement: 44 (1st round)
Content: Basic principles of operation of industrial robots should be integrated in a programme content

Score: 3.69

Statement: 24 (2nd round)
Content: Principles of design of medical architecture (e.g. hospital rooms, care centers, surgery rooms etc.) along with dedicated software should be integrated in practical activities.
Score: 3.71
Statement: 24 (1st round)
Content: Principles of design of medical architecture (e.g. hospital rooms, care centers, surgery rooms etc.) along with dedicated software should be integrated in practical activities.
Score: 3.44

Statement: 25 (2nd round)
Content: Virtual reality applications aiding the design of medical architecture (e.g. VR hospital configurator) should be integrated in practical activities.
Score: 3.86
Statement: 25 (1st round)
Content: Virtual reality applications aiding the design of medical architecture (e.g. VR hospital configurator) should be integrated in practical activities.
Score: 3.63

Statement: 16 (1st round)
Content: Basic principles of programming of medical robots should be integrated in practical activities.
Score: 3.70

Statement: 17 (2nd round)
Content: General robot programming course (online and offline programming) should be integrated in practical activities.
Score: 3.54
Statement: 17 (1st round)
Content: General robot programming course (online and offline programming) should be integrated in practical activities.
Score: 3.72

Soft skills & management & ergonomics in relation to requirements of people with special needs

SCORE: 3.76

This section includes:

- Psychology, patient relations
- sociological issues
- team and project management
- general management
- quality management
- ergonomics

Statement: 56 (1st round)
Content: Soft skills for contact with people with special needs should be integrated in a programme content.
Score: 3.80

Statement: 54 (2nd round)
Content: Physiological person-environment fit: evolutionary and medical aspects should be integrated in a programme content.
Score: 3.46
Statement: 54 (1st round)
Content: Physiological person-environment fit: evolutionary and medical aspects should be integrated in a programme content.
Score: 3.56

Statement: 55 (2nd round)
Content: Holistic psychology and wellness of people with special needs should be integrated in a programme content.
Score: 3.33
Statement: 55 (1st round)
Content: Holistic psychology and wellness of people with special needs should be integrated in a programme content.
Score: 3.77

Statement: 58 (2nd round)

Content: Building for equality: disability and the built environment, legal requirement of architecture of buildings for people with special needs should be integrated in a programme content.
Score: 3.57

Statement: 58 (1st round)
Content: Building for equality: disability and the built environment, legal requirement of architecture of buildings for people with special needs should be integrated in a programme content.
Score: 3.73

Statement: 60 (2nd round)
Content: Quality management tools and systems in biomedical engineering should be integrated in a programme content.
Score: 3.79
Statement: 60 (1st round)
Content: Quality management tools and systems in biomedical engineering should be integrated in a programme content.
Score: 3.71

Statement: 37 (2nd round)
Content: Project management strategies and advanced task management software tools should be integrated in practical activities.
Score: 3.64
Statement: 37 (1st round)
Content: Project management strategies and advanced task management software tools should be integrated in practical activities.
Score: 3.50

Statement: 3 (1st round)
Content: Complementary to face to face discussion in relevance to journal papers as a teaching method should be integrated in a programme content.
Score: 3.69

Statement: 59 (1st round)
Content: Management skills and other soft skills should be practiced and integrated in a programme content.
Score: 3.70

Statement: 15 (1st round)
Content: Human-centered design, offering holistic methodologies for defining, solving problems and innovating in oral healthcare should be integrated in practical activities.
Score: 3.77

Statement: 53 (1st round)
Content: Patenting and intellectual property protection in context of innovative medical devices should be integrated in a programme content.
Score: 3.80

Statement: 6 (1st round)
Content: Interactive lectures and discussions as teaching methods should be integrated in a programme content.
Score: 4.15

Statement: 1 (1st round)
Content: Ergonomics as a scientific and practical field: efficiency-safety-convenience in transforming, developing different environments, especially work environment adjusted to work with people with special needs should be integrated in a programme content.
Score: 4.10

Statement: 24 (1st round)
Content: Ergonomics of workstation design including the principles of work with screen monitors should be integrated in a programme content.
Score: 3.84

Statement: 5 (1st round)
Content: Case studies, films and presentations as teaching methods should be integrated in a programme content.
Score: 3.97

Statement: 57 (1st round)
Content: Accessibility for people with special needs should be integrated in a programme content.
Score: 3.92

Statement: 4 (1st round)
Content: Brainstorming and teamwork as teaching methods should be integrated in a programme content.
Score: 3.98

Statement: 3 (1st round)
Content: Anthropometry: human body data in ergonomic assessments and developments should be integrated in a programme content.
Score: 3.97

2. Terms of reference

Learning outcomes are statements of what a learner knows, understands and is able to do on completion of a learning process. Learning outcomes are defined in terms of knowledge, skills and competences.

Knowledge means the body of facts, principles, theories and practices that is related to a field of work or study. It is described as theoretical and/or factual knowledge.
Skill means the ability to apply knowledge and use know-how to complete tasks and solve problems. They are described as cognitive (logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments).
Social competence means the proven ability to use knowledge, skills and personal, social and methodological abilities in work or study situations and in professional and personal development.

Therefore, each section should not solely be a statement of facts or content but should be preceded with a verb and possibly adverb/adjective. Examples:
Knowledge: He/she is able to...
... describe XXX.
... assign XXX.
... differentiate between XXX.
Skills: He/she is able to...
... receive XXX.
... analyse XXX and present XXX.
... use XXX.
... develop XXX.
Social competence (in the sense of taking over responsibility and autonomy): He/she is able to...
... apply problem solving strategies
... reflect upon …
... cope with ….

… communicate with...

3. ErgoDesign Course Curriculum And Competence Framework

The initial proposed course curriculum consisted of six modules:

1. Biomaterials and their processing technologies
2. Design, imaging and digital support for medical device design
3. IT solutions in medicine
4. Basic medical issues
5. Medical equipment, hospital equipment
6. Soft skills & management & ergonomics in relation to requirements of people with special needs

However, the primary composition was developed into the final course structure after project team internal discussions:

1. Introduction: The benefits of implantology in the health care system, management of patience and production process (Soft skills + management + ergonomics)
2. Introduction of the biomaterials and biocompatible materials
3. Processing technologies of the biomaterials and biocompatible materials
4. 3D printing of the metals, ceramics and polymers
5. Anatomy of the implantology, geometry, sizes and general and special examples
6. Material selection for implant (use the knowledge of the biomaterials and biocompatible materials and their processing technologies) as a function of the anatomy of the application
7. Human implant compatibility test methods and surgery in implantology
8. Databases, programming, AI
9. Telemedicine system, medical informatics
10. 3D scanning, process and device
11. Medical Imaging (CT/MRI/USG)

12. Application of the 3D images for designing as a function of the processing technology (digital tools for designing)
13. Medical equipment, hospital equipment
14. Integrating exercise

CURRICULUM

Module Title:

Title: **3D printing for health care**
Subtitle: ***Improving digital skills for Ergonomics and Bioengineering Innovations for inclusive Health Care***

Short Description:

Specialised interdisciplinary education concept of theoretical and practical aspects of additive technologies application in biomedical engineering to enhance human health and wellbeing.

Course Description:

The course provides a specialised interdisciplinary education concept of theoretical and practical aspects of additive technologies application in biomedical engineering to enhance human health and wellbeing. The graduates gain a comprehensive understanding of core engineering principles related to the implants and prosthesis produced by additive technologies. The education concept is built for the ability to start an interesting career for highly skilled personnel in 3D printing for inclusive health care.

Students will utilise knowledge from the biomaterials and their processing technologies, basic medical issues, digital support in medicine, medical and hospital instrumentation, ergonomics, as well management of process of the 3D printing for health care. The applied complex of the interdisciplinary engineering knowledge and skills enables the graduate of the course to design and to produce personalised implants and prosthesis for improvement of human life.

Course Level:

Undergraduate / Graduate / Postgraduate / Lifelong education

Course Type:

Mandatory (included in the already existing course) or Elective (to organise a specific new course)

Duration

On-site: 14 weeks + 1 week for final examination

On-line: self-paced

Admission Process (Selection criteria):

Self-assessment test

Prerequisites:

1. Knowledge

Demonstrating knowledge at a level enabling their practical application in:

- Mathematics - Arithmetic / Algebra & Geometry / Trigonometry / Probability and Statistics / Calculus
- Descriptive geometry - Orthogonal projection of 3D objects
- Physics - Mechanics of rigid and flexible bodies and environments / Kinematics
- Chemistry - Chemical bonds / Solids & Liquids & Solutions / Chemical reactions – Oxidation & Reduction
- Material science - Crystalline solids & Ceramics & Polymers structure & properties / Imperfections in Solids / Diffusion / Dislocations and Strengthening / Degradation of materials
- Computer graphics - Basic 3D modelling theory
- Thermomechanics - an introductory background (first year university level)
- Hydromechanics - an introductory background (first year university level)

Mastering the

- Basics of materials technology and production of machine structures
- Methods and means of technical and experimental research of machines as well as the means of controlling machines and processes

Knowing the

- Principles of the main scientific methods of the professional field and using some of their basic variants in practical contexts

2. Skills

General digital skills on intermediate level - Digital foundation skills / Communicating / Handling information and content / Transacting / Problem-solving / Being safe and legal online

Ability to

- construct simple components, assemblies up to the design of a simpler machine with all the necessary strength calculations and economic balance sheets
- use professional terminology and process technical documentation
- read technical drawings of products or parts and propose the most efficient methods and procedures for their production
- analyse and evaluate technical solutions
- perform basic analysis of machinery and production technologies
- to carry out technical supervision at workplaces, check compliance with technological procedures
- verify new production procedures, collaborate on the implementation of technological changes and innovative activities
- prepare, carry out and compile a report on the result of a laboratory experiment
- provide technical preparations for changes to the assortment and introduce new products
- determine the method of quality control and technical tests, to cooperate on production quality control
- PROBABLY THIS NO - design technical facilities and their number, kind and type of machines and machinery for production based on the established procedure and target capacity
- PROBABLY THIS NO - ensure and organize the technological preparations of engineering production, to propose the layout of machines and fixtures, the flow of material, the continuity of workplaces and other technical conditions

3. Attitudes

Application of knowledge and understanding in a way that shows a professional approach to their work or profession, and they have competences that are usually demonstrated by creation and defending arguments and solving problems in this professional field.

Collecting and interpreting relevant data (usually in the professional field) and reach judgments from them that also consider relevant social, scientific and ethical consequences.

Communication of information, ideas, problems and solutions to both experts and lay people

Ability of independent learning and studying

List of contents

1. Introduction: The benefits of implantology in the health care system, management of patience and production process (Soft skills + management + ergonomics) for people with special needs
2. Introduction of the biomaterials and biocompatible materials
3. Processing technologies of the biomaterials and biocompatible materials
4. 3D printing of the metals, ceramics and polymers
5. Anatomy of the implantology, geometry, sizes and general and special examples
6. Material selection for implant (use the knowledge of the biomaterials and biocompatible materials and their processing technologies) as a function of the anatomy of the application
7. Human implant compatibility test methods and surgery in implantology.

8. Databases, programming, AI
9. Telemedicine system, medical informatics
10. 3D scanning, process and device
11. Medical Imaging (CT/MRI/USG)
12. Application of the 3D images for designing as a function of the processing technology (digital tools for designing)
13. Medical equipment, hospital equipment
14. Integrating exercise

Learning outcomes

1. Knowledge

Graduate will be able**:**

- to identify the need of use of biomaterials for 3D printing on his own in health care,
- to understand the requirement of biomaterials and biocompatible materials,
- to understand basic human body functions / working and ability to complex suggestion procedures,
- to understand basic medical issues in health care service,
- to understand the attitude how to address to people with special needs and adopt inclusive centred approach with soft skills and emotions,
- to understand basic knowledge for management for inclusive health care.

2. Skills

Graduate will be able**:**

- to select the most appropriate material for real application,
- to propose an inclusive solution to medical product development,
- to work with patient data and using digital tools for implantology and prosthetics,
- to select appropriate technology (casting, CNC, 3D printing, surface processing, heat treatment, colouring) for implants and prosthetics production,
- to design implants and prosthetics with free available software,
- to use medical tools (medical imaging and 3d scanning) for people with special needs,
- to use ergonomics methodologies and tools for manufacturing personalised implants/prothesis,

3. Attitude:

- Application of knowledge and understanding in a way that shows a professional approach to their work or profession, and they have competences that are usually demonstrated by creation and defending arguments and solving problems in this field of study,
- Collecting and interpreting relevant data (usually in their own field of study) and from them reach judgments that also take into account relevant social, scientific and ethical problems;
- Communication of information, ideas, problems and solutions to both experts and lay people;
- Developed the ability for further education, necessary for studying with a high degree of independence.

Teaching methods

- Activating (simulation, games, dramatisation)
- Monological (lecture, instruction)

- Dialogic (Discussion, conversation, brainstorming)
- Demonstration
- Lecturing
- E-learning
- Methods of working with the text (study book, book)
- Individual work of students
- Students work in pairs
- Teamwork
- Laboratory work
- Exercise on the computer
- Practice exercises
- Dealing with situational issues - learning in situations

Methods for verifying learning outcomes and assessment criteria (Examination):

Learning outcomes are verified as follows:
Self-assessment (not mandatory) in a form of a quiz after each topic
5 out of 20 questions will be chosen from a question bank
Final test will be carried out after studying 13 topics. For this aim we will use the question bank and will chose 10 questions
For 14 topics a practical task will be assigned for an assessment.

Assessment scale (applicable for a final test):

Assessment scale:
A 94 – 100%
B 89 – 94%
C 81 – 88%
D 73 – 80%
E 66 – 72%
F 0 – 65 %

Scope/duration of online training:

14 weeks of education and 15th week for final test

n. of ECTS recommended:

at least 3 ECTS

The details of each topics are provided in topic description cards which are included in Appendixes 1-14.

Appendixes for Topic Area 1-14

Co-funded by the European Union

TOPIC DESCRIPTION CARD

Topic name: Introduction: The benefit of implantology in the health care system, management of patient and production process

Number of hours per topic: 3 hours
Lectures
3 hours

Responsible for the course/lecturer:

Associate Professor Tünde Anna Kovács
Email: kovacs.tunde@bgk.uni-obuda.hu
Óbuda University
Bánki Donát Faculty of Mechanical and Safety Engineering

Prerequisites

1 Knowledge:
-knowledge of the basic material sciences
-knowledge basic cad applications
-knowledge basic mechanics
-
2. Skills:
-basic skills in the operation of computer system
-communication skills
-
3. Attitude:
- student understands the need of gathering new knowledge and skills
- student can self-develop new skills and knowledge
-

Topic objective
The aim of “The benefit of implantology in the health care system, management of patience an production process” is to show how to get from the definition of the problem to the solution. The problem is the missing tooth, which can be replaced with an implant. The steps to solve the problem are the assessment of the missing tooth, the design and manufacture of the implant, and then the surgery. This is the process

of communicating with the patient included of implantology process in the health care system, management of patient.

Topic-related learning outcomes

1 Knowledge:
-Students understand the health care system communication.
-Describe the implantology process steps

-
2. Skills:
-basic skills in operation of computer system
-skills to use browsers with useful keywords
-
3. Attitude:
- student understands the need of gathering new knowledge and skills
- student can self-develop new skills and knowledge
-

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:
- Lectures:
-on the basis of answers to the questions regarding material from previous lectures

-
Assessment scale:
Lectures:
--evaluation of knowledge by a written final test with open and closed questions, questions are assessed on a point scale, and to pass is required to collect at least 50% of the total possible number of points

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Programme content

-Communication with the patient
-Problem definitions
    missing tooth
    solutions possibilities
-Steps of the implantology
    -CT or Xray imaging system
    -designing of the implant
    -material selection
    -Final treatment of the implant

-Operation
    -implantation
    -recovering and health care
    -control of the recovered patient
-Communication with the patient
    aftercare
    life with implant

Teaching methods
Informative lecture
Multimedia presentation

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Additional
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Co-funded by the European Union

TOPIC DESCRIPTION CARD

Topic name: Introduction of the biomaterials and biocompatible materials

Number of hours per topic: 3 hours
Lectures
3 hours

Responsible for the course/lecturer:

Associate Professor Tünde Anna Kovács
Email: kovacs.tunde@bgk.uni-obuda.hu
Óbuda University
Bánki Donát Faculty of Mechanical and Safety Engineering

Prerequisites

1 Knowledge:
-knowledge of the requirements and properties of biocompatible materials
-knowledge of the requirements and properties of biomaterials
-knowledge of the degradation forms of the biomaterials and biocompatible materials
-
2. Skills:
-basic skills in operation of computer system
-skills to use browsers with useful keywords
-
3. Attitude:
- student understands the need of gathering new knowledge and skills
- student can self-develop new skills and knowledge
-

Topic objective
The aim of “Introduction of biomaterials and biocompatible materials” is to give the student basic knowledge about the properties of biomaterials and biocompatible materials. The difference between biomaterials and biocompatible materials should be explained. Biomaterials are integrated into human tissue, and then the body rebuilds them into its own cells. Biocompatible materials attach to the human body

without irritation but always retain their own material properties. With this knowledge, you can choose a material for a given implant. Understand the degradation processes of the biomaterials and biocompatible materials.

Topic-related learning outcomes

1 Knowledge:
-Students understand the difference between the biocompatible and biomaterials.
-Describe the properties and structure of the biomaterials and biocompatible materials.
-Recognize the type of degradation of biocompatible and biomaterials

-
2. Skills:
-basic skills in operation of computer system
-skills to use browsers with useful keywords
-
3. Attitude:
- student understands the need of gathering new knowledge and skills
- student can self-develop new skills and knowledge
-

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:
- Lectures
-on the basis of answers to the questions regarding material from previous lectures

-
Assessment scale:
Lectures:
--evaluation of knowledge by a written final test with open and closed questions, questions are assessed on a point scale, and to pass is required to collect at least 50% of the total possible number of points

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Programme content

-Biomaterials properties
    human source biomaterials (donor, own)
    natural materials
    synthetic materials
-Biocompatible materials
    -polymers
    -ceramics

-metals and alloys
-composites
-Material testing
-bicompatibility tests
-degradation tests
-mechanical properties tests
-corrosion test
-wear test

Teaching methods
Informative lecture
Multimedia presentation

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Additional
1. Osman RB, Swain MV. A Critical Review of Dental Implant Materials with an Emphasis on Titanium versus Zirconia. Materials 2015, 8, 932-958
2. Wang, SH., Hsu, JT., Fuh, LJ. et al. New classification for bone type at dental implant sites: a dental computed tomography study. BMC Oral Health 23, 324 (2023). https://doi.org/10.1186/s12903-023-03039-2

Co-funded by the European Union

TOPIC DESCRIPTION CARD

Topic name: Processing technologies of the biomaterials and biocompatible materials

Number of hours per topic: 3 hours
Lectures
3 hours

Responsible for the course/lecturer:

Associate Professor Angelos Markopoulos
Email: amark@mail.ntua.gr
National Technical University of Athens
School of Mechanical Engineering

Prerequisites

1 Knowledge:
- basics knowledge of properties biomaterials
- basics knowledge of manufacturing technologies

2. Skills:
- basic skills in operation of computer systems
- skills in finding information in scientific libraries and Internet
- logical thinking

3. Attitude:
- student understands the need of gathering new knowledge and skills
- student can self-develop new skills and knowledge
- student can work in a team

Topic objective
The aim of “Processing technologies of the biomaterials and biocompatible materials” is to give the student basic knowledge about processing technologies of biomaterials and biocompatible materials. These technologies involve various methods to transform raw materials into usable forms for biomedical applications. Moreover, these technologies can modify the composition, structure, and properties of the materials to achieve specific functionalities and ensure compatibility with biological systems.

Topic-related learning outcomes

1 Knowledge:
- Students understand the basic processing technologies of the biomaterials
- Describe the composition, structure and mechanical properties of the main classes of biomaterials: metals, ceramics, polymers, composites; explain and give an example of how composition, structure and treatment modify the mechanical properties.
- Describe and give examples of how biomaterials are used to fabricate for clinical use.

2. Skills:
- basic skills in operation of computer systems
- skills in finding information in scientific libraries and Internet
- logical thinking

3. Attitude:
- student understands the need of gathering new knowledge and skills
- student can self-develop new skills and knowledge
- student can work in a team

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:
Lectures:
-on the basis of answers the questions regarding material from previous lectures

Assessment scale:
Lectures:
-evaluation of knowledge by written final test with open and closed questions, questions are assessed on a point scale, and to pass is required to collect at least 50% of the total possible number of points

Programme content

-Manufacture of Metals for Biomedical Applications
Chemical Metallurgy
- Forming Operations
- Casting
- Additive manufacturing

Physical Metallurgy
- Heat treatment

- Machining of Metallic Biomaterials

- Manufacture of Biomedical Polymers
Polymer Synthesis
  - Step-growth polymerization
  - Addition polymerization

Polymer Forming Techniques
  - Injection molding
  - Extrusion

Fabrication of Hydrogels

- Manufacture of Bioceramics
  - Liquid-phase sintering
  - Solid state sintering

- Manufacture of Biomedical Composites
  - Fabrication of Fibrous Biomedical Composites
  - Fabrication of Laminated Structures
  - Fabrication of Porous Composite Scaffolds for Tissue Engineering

- Surface Modification Techniques for Biomaterials

Teaching methods

Informative lecture
Multimedia presentation

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Co-funded by the European Union

TOPIC DESCRIPTION CARD

Topic name: **3D printing of the metals, ceramics and polymers**

Number of hours per topic: 3 hours
Lectures
2 hours
Laboratory classes
1 hours

Responsible for the course/lecturer:

Assoc. Prof. Filip Górski, PhD., Eng.

email: filip.gorski@put.poznan.pl
Poznan University of Technology
Faculty of Mechanical Engineering

MEng Justyna Rybarczyk
email: Justyna.Rybarczyk@doctorate.put.poznan.pl
Poznan University of Technology
Faculty of Mechanical Engineering

Prerequisites

1 Knowledge:
- in scope of information technologies and technical drawing, CAD/CAM, manufacturing technologies,
- of orthopaedic and prosthetic supplies.

2. Skills:
- in solid modelling of an object in a CAD 3D system,
- designing an orthopaedic or prosthetic supply.

3. Social competences:
- cooperation in a project team,
- awareness of responsibility for assigned tasks,
- understanding the need for new knowledge.

Topic objective
The aim of classes is to learn about modern incremental manufacturing techniques in layers, also referred to as three-dimensional printing. To acquire the ability to apply additive manufacturing for rapid fabrication of physical prototypes.

Topic-related learning outcomes

1 Knowledge:
- Has an ordered, theory-based general knowledge about modern designing and manufacturing techniques.
- Has knowledge of additive manufacturing and its advantages and disadvantages compared to other manufacturing techniques.
2. Skills:
- Is able to make appropriate changes in the technological process of additive manufacturing in order to change the value of specific technical coefficient of the product.
- Is able to make a detailed assessment of the structure's technology and indicate the possibilities of its improvement. Is able to communicate in this regard with technologists and designers.
- Is able to prepare a team to carry out an innovative project, select a team of implementers, using project management methods, can define tasks related to the implementation process of the project and be a leader of the project team.
3. Social competences:
- Is able to properly set priorities for achieving the goal set by himself or other team members.
- Correctly identifies and resolves dilemmas related to the performance of ongoing tasks. Is aware of the need to prepare and organize the work of the members of the team.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lectures: on the basis of knowledge test.

Laboratory-course: on the basis of the student's preparation for each laboratory activity.

Assessment scale:

Lectures:

- evaluation of knowledge by written final test with open and closed questions; questions are assessed on a point scale, and to pass it is required to collect at least 50% of the total possible number of points

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Programme content

Lectures:

1. 3D Printing - general issues of additive manufacturing technology in layers.
2. Division and a brief presentation of the most important methods of incremental manufacturing. Case study

Laboratory-course:

1. manufacturing of products on FDM/FFF machines.

Teaching methods
- informative lecture
- multimedia presentation
- case study

Bibliography
Basic
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2. Bhate Dhruv, 2018, "Design for Additive Manufacturing: Concepts and Considerations for the Aerospace Industry", SAE International, Warrendale, USA.

Co-funded by the European Union

TOPIC DESCRIPTION CARD

Topic name: Anatomy of the implantology, geometry, sizes and general and special examples

Number of hours per topic: 3 hours
Lectures
3 hours

Responsible for the course/lecturer:

Prof. Assoc. Tihomir Dovramadjiev PhD Eng.
Technical University of Varna, Bulgaria
Lecturer PhD Candidate Diana Pavlova
Training and Development Specialist at SWISS Dentaprime

Prerequisites

1 Knowledge:
Fundamental understanding of human anatomy, with a focus on bone and soft tissue structures. Familiarity with basic concepts in dental and orthopedic implantology is recommended.

2. Skills:
Skills in conducting research and using scientific databases to extract relevant information. Strong analytical and logical thinking skills are essential for evaluating anatomical data and applying geometric principles to clinical scenarios.

3. Attitude:
Students must demonstrate effective communication skills to collaborate within interdisciplinary teams and adhere to ethical standards in patient care.

Topic objective

This topic provides a general overview of the anatomical foundations that are critical to implantology, focusing on the complex relationships between bone, muscle, tendon, and connective tissue. It emphasizes the importance of understanding these structures for successful implant design, placement, and integration. The topic delves

into the geometric and dimensional considerations that are essential for implants, illustrating these concepts with general and special examples and cases. By integrating anatomical knowledge with practical applications, students will gain a thorough understanding of how to achieve optimal restoration of function and aesthetics in both dental and orthopedic contexts. The topic aims to provide learners with the necessary knowledge and skills to navigate complex anatomical scenarios and make informed decisions in implantology practice, promoting competence and confidence in clinical settings.

Topic-related learning outcomes

1 Knowledge:

- Show a comprehensive understanding of the anatomical features and structures relevant to implantology, including the intricate topography surrounding implant sites and the interplay of bone, muscle, and connective tissue.
- Explain the importance of anatomical analysis in successful implant placement and integration, considering anatomical variations and their impact on treatment outcomes.
- Evaluate and analyze different implant designs, including their geometries, sizes, and dimensional considerations, and understand their implications for load distribution, stability, and osseointegration.
- Identify and differentiate between general and special examples in implantology, applying anatomical knowledge and implant design principles to address diverse clinical scenarios and challenges.challenges.
- Recognize the interdisciplinary nature of implantology and appreciate the integration of different fields, such as dentistry, orthopaedics, biomaterials, and engineering, in achieving optimal outcomes.
- Apply critical thinking skills to assess anatomical variations, consider patient-specific factors, and make informed decisions regarding implant selection, placement, and restoration.
- Understand the advancements and emerging trends in implantology, staying updated with the latest research, technologies, and innovations in the field.
- Promote effective communication and collaboration skills in interdisciplinary settings, fostering teamwork and knowledge exchange among practitioners from different disciplines.

2. Skills:

- Conduct anatomical analysis and apply critical thinking skills to assess the anatomical features of implant sites, identify anatomical variations, and determine their implications for implant placement.
- Present proficiency in problem-solving by integrating anatomical knowledge, geometric considerations, and dimensional requirements to select appropriate implant designs and sizes for individual patients.

- Utilize spatial awareness and visualization skills to accurately position and place implants within the natural dentition or skeletal structures, considering esthetic and functional restoration.
- Communicate effectively with interdisciplinary teams, collaborating with professionals from different fields to integrate anatomical understanding, implant design principles, and interdisciplinary approaches in complex cases.
- Promote proficiency in using advanced imaging techniques and technologies to aid in anatomical analysis, implant planning, and treatment decision-making.
- Apply ethical considerations and professionalism in the practice of implantology, ensuring patient-centered care, informed consent, and adherence to professional standards and guidelines.
- Develop effective communication skills to educate patients about the anatomical considerations, implant options, and treatment plans, facilitating shared decision-making and ensuring patient satisfaction.
- Cultivate a lifelong learning mindset, staying updated with advancements in implantology, engaging in continuous professional development, and seeking opportunities for research and further specialization in the field.

3. Attitude:
   - Professionalism: Graduates will adopt a professional attitude, demonstrating integrity, ethical conduct, and a commitment to providing the highest standard of care to patients. They will prioritize patient well-being, respecting their autonomy, and ensuring their comfort and satisfaction throughout the implantology process.
   - Patient-Centered Approach: Graduates will embrace a patient-centered approach, recognizing the importance of understanding patients' individual needs, preferences, and goals. They will value effective communication and empathy, actively involving patients in treatment decisions, and empowering them to make informed choices.
   - Lifelong Learning: Graduates will cultivate a mindset of lifelong learning and professional development. They will appreciate the dynamic nature of implantology and the need to stay updated with advancements in the field. They will actively seek opportunities to enhance their knowledge, skills, and expertise through continued education, research, and engagement with professional communities.
   - Collaboration: Graduates will recognize the value of collaboration and interdisciplinary teamwork in delivering comprehensive implantology care. They will foster positive relationships with colleagues from different disciplines, respecting their expertise and actively contributing to a multidisciplinary approach to patient care.
   - Adaptability: Graduates will develop an attitude of adaptability, embracing new technologies, techniques, and research findings in implantology. They will be open to innovation, willing to explore and incorporate advancements that can enhance treatment outcomes and patient experiences.

- Critical Thinking: Graduates will cultivate a critical thinking mindset, approaching implantology cases with a thorough and analytical perspective. They will evaluate evidence, consider multiple factors, and make well-reasoned decisions based on the unique needs of each patient.
- Confidence and Resilience: Graduates will develop confidence in their knowledge, skills, and abilities in implantology. They will exhibit resilience in the face of challenges, embracing them as opportunities for growth and learning. They will approach complex cases with a positive and determined attitude, seeking innovative solutions and persisting in their pursuit of optimal outcomes.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Final course exam
Learning outcomes are verified as follows:
Final test will be carried out after studying topics.
-
Assessment scale:
Lectures:
-evaluation of knowledge by a written final test with open and closed questions, questions are assessed on a point scale, and to pass is required to collect at least 50% of the total possible number of points

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Programme content

1. Implantology in general
2. Implantology as a discipline.
3. Anatomical foundations & significance of anatomy in implantology.
4. Human bone anatomy.
5. Interplay of bone / jaws / connective tissue & osseointegration
6. Geometry, sizes and dimensionality in implantology
7. Special examples in implantology
8. Implementation of 3D design (digital & physical) & advanced technologies in implantology.

Teaching methods

- Monological (lecture, instruction)
- Dialogic (Discussion, conversation, brainstorming)
- Demonstration
- Lecturing

- E-learning
- Methods of working with the text (study book, book)
- Individual work of students
- Teamwork
- Practice exercises

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Co-funded by the European Union

TOPIC DESCRIPTION CARD

Topic name: Material selection for implant (use the knowledge of the biomaterials and biocompatible materials and their processing technologies) as a function of the anatomy of the application

Number of hours per topic: 3 hours
Lectures
3 hours

Responsible for the course/lecturer:

Associate Professor Angelos Markopoulos
Email: amark@mail.ntua.gr
National Technical University of Athens
School of Mechanical Engineering

Prerequisites

1 Knowledge:
- basics knowledge of properties biomaterials
- basics knowledge of manufacturing technologies

2. Skills:
- basic skills in operation of computer systems
- skills in finding information in scientific libraries and Internet
- logical thinking

3. Attitude:
- student understands the need of gathering new knowledge and skills
- student can self-develop new skills and knowledge
- student can work in a team
- student is not sensitive to openly shown images of human body (internals and externals) and its various physiopathologies

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Topic objective
The aim of “Material selection for implant (use the knowledge of the biomaterials and biocompatible materials and their processing technologies) as a function of the

anatomy of the application" is to give the student the basic knowledge about how several factors, for example, biocompatibility, mechanical properties, processing methods, and specific application requirements, are necessary to examine the suitability of a material to be an implant. It's useful for the student to understand that the selection of a specific material and a processing method, should be made by taking into account the patient's needs, medical regulations, and the latest advancements in biomaterials research.

Topic-related learning outcomes

1 Knowledge:
- Students will be able to understand the requirement of biomaterials and biocompatible materials
- Students will be able to select the most appropriate material for a real application

2. Skills:
- basic skills in operation of computer systems
- skills in finding information in scientific libraries and Internet
- logical thinking

3. Attitude:
- student understands the need of gathering new knowledge and skills
- student can self-develop new skills and knowledge
- student can work in a team
- student is not sensitive to openly shown images of human body (internals and externals) and its various physiopathologies

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Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:
Lectures:
-on the basis of answers the questions regarding material from previous lectures

Assessment scale:
Lectures:
-evaluation of knowledge by written final test with open and closed questions, questions are assessed on a point scale, and to pass is required to collect at least 50% of the total possible number of points

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Programme content

- Specific anatomical requirements
- Mechanical and chemical properties of biomaterials

- Biocompatibility of biomaterials
- Bone implants
- Dental implants
-Cardiovascular Implants
- Soft Tissue Implants

Teaching methods
Informative lecture
Multimedia presentation

Bibliography
Basic
1. Ratner, B. D., Director, C. E., Hoffman, A. S., Schoen, F. J., Lemons, J. E., Boston, A., London, H., Oxford, N. Y., San, P., San, D., Singapore, F., & Tokyo, S. (2004). BIOMATERIALS SCIENCE An Introduction to Materials in Medicine 2nd Edition. www.academicpress.com
2. Roger Narayan, (2019). ENCYCLOPEDIA OF BIOMEDICAL ENGINEERING 2nd Edition, Elsevier.

Co-funded by the European Union

TOPIC DESCRIPTION CARD

Topic name: Human implant compatibility test methods and surgery in implantology

Number of hours per topic: 3 hours
Lectures
3 hours

Responsible for the course/lecturer:

Associate Professor Angelos Markopoulos
Email: amark@mail.ntua.gr
National Technical University of Athens
School of Mechanical Engineering

Prerequisites

1 Knowledge:
- basics of physics and chemistry
- basics of biology
- basic knowledge of computer systems

2. Skills:
- skills in searching and interpreting information from the Internet
- logical thinking

3. Social competences:
- student understands the need of gathering new knowledge and skills
- student can self-develop new skills and knowledge
- student can work in a team
- student is not sensitive to openly shown images of human body (internals and externals) and its various physiopathologies

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Topic objective
The aim of “Human implant compatibility test methods and surgery in implantology” is to give the student basic knowledge about biocompatibility and safety of the implant material before it is used in a surgical procedure. Human implant compatibility testing is an essential step in the development and evaluation of biomaterials intended for

implantation in the human body. These tests are conducted to assess the safety, biocompatibility, and performance of the implant material.

Topic-related learning outcomes

1 Knowledge:
- Students will be able to understand basic knowledge about biocompatibility and safety of the implant material

2. Skills:
skills in searching and interpreting information from the Internet
- logical thinking

3. Social competences:
- student understands the need of gathering new knowledge and skills
- student can self-develop new skills and knowledge
- student can work in a team
- student is not sensitive to openly shown images of human body (internals and externals) and its various physiopathologies

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Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:
Lectures:
-on the basis of answers the questions regarding material from previous lectures

Assessment scale:
Lectures:
-evaluation of knowledge by written final test with open and closed questions, questions are assessed on a point scale, and to pass is required to collect at least 50% of the total possible number of points

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Programme content
-In vitro Testing
-In vivo testing
- Evaluation of blood
- Animal Studies
-Clinical Trials
- Standards for Biomaterials

Teaching methods
Informative lecture
Multimedia presentation

Bibliography
Basic
1. Ratner, B. D., Director, C. E., Hoffman, A. S., Schoen, F. J., Lemons, J. E., Boston, A., London, H., Oxford, N. Y., San, P., San, D., Singapore, F., & Tokyo, S. (2004). BIOMATERIALS SCIENCE An Introduction to Materials in Medicine 2nd Edition. www.academicpress.com
2. Roger Narayan, (2019). ENCYCLOPEDIA OF BIOMEDICAL ENGINEERING 2nd Edition, Elsevier.

Co-funded by the European Union

TOPIC DESCRIPTION CARD

Topic name: **Databases, programming, AI**

Number of hours per topic: 4 hours
Lectures
2 hours
Tutorials
2 hours

Responsible for the course/lecturer:

Peter Pavol Monka

Prerequisites

1 Knowledge:
- None

2. Skills:
- Working in one of the common operating systems environment;
- Ability to create the data structure in spreadsheet processors;

3. Social competences:
- None

Topic objective
The subject follows the essential digital competences.
In the area of the basics of data management, it builds basic knowledge through tabular database structures and their development into relational structures.
In the field of programming, he develops basic programming knowledge and skills for specific health care issues.
The third education group of the subject are typical applications of artificial intelligence in healthcare.
An important part of the education is the student's independent work focused on understanding the efficient storage and processing of data through a suitable data structure, basic programming techniques and simple applications of artificial intelligence.

Topic-related learning outcomes

1 Knowledge:
- Understanding the principles of the simple tabular datasheet and relational database;
- Understanding of the basic programming for the applications in health care;
- Understanding of the basic applications of artificial intelligence.

2. Skills:
- Ability to build simple tabular database;
- Ability to build simple relational database;
- Ability to use a simple programming for automation of data processing;
- Ability to use simple tools for artificial intelligence application for processing heal care data.

3. Social competences:
- Ability to work independently on simple database and data processing tasks.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:
Analyse of student performance on:
- Building a simple table database;
- Building a simple relational database;
- Creating a simple program for database;
- Simple application of artificial intelligence for data processing.

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Assessment scale:
Lectures:
--evaluation of knowledge by a written final test with open and closed questions, questions are assessed on a point scale, and to pass is required to collect at least 50% of the total possible number of points

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Programme content

1. Simple tabular databases
2. Relational databases
3. Basic programming for the data processing
4. Basic artificial intelligence tools for the data processing

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Teaching methods

Lecturing
Dialogic (Discussion, conversation, brainstorming)
Practice exercises

Bibliography

Basic
1. Manning A.: Databases for Small Business - Essentials of Database Management, Data Analysis, and Staff Training for Entrepreneurs and Professionals, Apress, 2015, ISBN 978-1-4842-0278-4

Co-funded by the European Union

TOPIC DESCRIPTION CARD

Topic name: Telemedicine system, medical informatics

Number of hours per topic: 3 hours
Lectures
3 hours

Responsible for the course/lecturer:

Prof. Rozalina Dimova PhD Eng.
Prof. Chief Assist. Ginka Marinova PhD Eng.
Technical University of Varna, Bulgaria

Prerequisites

1 Knowledge:
- Basic knowledge of telemedicine system
- Basic knowledge of medical informatics

2. Skills:
- Skills for finding information in scientific libraries
- Logical thinking

3. Attitude:
None

Topic objective

The objective of this topic is to provide a comprehensive introduction to the field of telemedicine and its application in modern healthcare. Students will explore the use of telecommunications technologies to deliver healthcare services remotely, improve access to care, and improve patient outcomes. In addition, the course covers the integration of medical informatics principles and technologies into telemedicine systems. Students will explore the historical development of telemedicine, its advantages and limitations, and the ethical and legal considerations associated with its practice. They will gain a solid understanding of telecommunications technologies

used in telemedicine, such as transmission systems, remote monitoring, and mobile health applications.

Topic-related learning outcomes

1 Knowledge:

- Students define and explain the concept of telemedicine, its scope, and its role in modern healthcare delivery.
- Students identify and discuss the historical evolution of telemedicine and its impact on healthcare practices.
- Students evaluate the benefits and limitations of telemedicine in improving healthcare access, quality, and patient outcomes.
- Students analyze the ethical and legal considerations involved in the practice of telemedicine and the protection of patient privacy and data security.
- Students describe the telecommunication technologies used in telemedicine.
- Students understand the principles of medical informatics and its applications in telemedicine.
- Students explore various telemedicine applications, such as teleconsultation, remote patient monitoring, and their specific benefits and challenges.
- Students assess the implementation challenges and strategies for successful adoption of telemedicine in healthcare organizations.
- Students evaluate the future trends and innovations in telemedicine, including the role of artificial intelligence, virtual reality and the Internet of Medical Things.
- Students apply knowledge and skills gained throughout the course to critically analyze and propose telemedicine solutions for specific healthcare scenarios and challenges.

2. Skills:

- Students have technical Skills: Proficiency in using telecommunication technologies and platforms commonly employed in telemedicine.
- Students have critical Thinking and Problem-Solving Skills: Capacity to assess healthcare scenarios and identify suitable applications of telemedicine. Ability to analyze and evaluate the ethical and legal implications of telemedicine practices and make informed decisions.
- Students have communication and Collaboration Skills: Effective communication with patients, healthcare professionals, and stakeholders through telemedicine platforms. Collaboration and coordination with multidisciplinary teams and training patients and healthcare professionals on using telemedicine technologies and platforms.
- Students have adaptability and Technology Literacy: Adaptability to new technologies. Competence in troubleshooting common technical issues that may arise during telemedicine consultations or data exchange.

3. Attitude:
- Students foster an open-minded attitude towards telemedicine and its potential in transforming healthcare delivery.
- Students develop a patient-centric mindset, prioritizing the needs and well-being of patients when considering the application of telemedicine in healthcare.
- Students cultivate a strong sense of ethical awareness and responsibility in the practice of telemedicine.
- Students value the importance of collaboration and interdisciplinary teamwork in the successful implementation of telemedicine.
- Students cultivate critical thinking skills to evaluate and assess the suitability of telemedicine solutions for different healthcare scenarios.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:
- Lectures
-on the basis of answers to the questions regarding material from previous lectures

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Assessment scale:
Lectures:
--evaluation of knowledge by a written final test with open and closed questions, questions are assessed on a point scale, and to pass is required to collect at least 50% of the total possible number of points

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Programme content

1. Telemedicine in general.
2. Telecommunication Technologies in Telemedicine.
3. Medical Informatics in Telemedicine Information systems and people.
4. Telemedicine Applications.
5. Information and Communications technologies in the telemedicine.
6. Future Trends and Innovations in Telemedicine.
7. Ethics in collaborating with technology.
8. Telemedicine and healthcare transformation.

Teaching methods

- Monological (lecture, instruction)
- Dialogic (Discussion, conversation, brainstorming)
- Demonstration
- Lecturing

- E-learning
- Methods of working with the text (study book, book)
- Individual work of students
- Teamwork
- Practice exercises

Bibliography
Basic

1. W. Ed Hammond, Andrew S. Kanter, and Peter Winkelstein "Telemedicine and Telehealth: Principles, Policies, Performance, and Pitfalls", 2000, Springer, ISBN 978-0826113023
2. Robert E. Hoyt and Ann K. Yoshihashi Medical Informatics: Practical Guide for the Healthcare Professional" , 2018, ISBN 978-0557133239
3. Ramona Nelson and Nancy Staggers "Health Informatics: An Interprofessional Approach" , 2023 SBN 978-0323829595
4. David D. Luxton, Eve-Lynn Nelson, and Marlene M. Maheu Telemedicine: A Practitioner's Guide to Telemental Health: How to Conduct Legal, Ethical, and Evidence-Based Telepractice", 2023, ISBN 9781433822278
5. Marek, Jiri and Udo-Martin Gómez, “MEMS (Micro-Electro-Mechanical Systems) for Automotive and Consumer ” in Chips 2020: A Guide to the Future of Nanoelectronics, Höfflinger, Bernd, Ed., Heidelberg, Springer-Verlag, 2012, pp. 293–314
6. Li, Jason Jingshi, Boi Faltings, Olga Saukh, David Hasenfratz, and Jan Beutel, “Sensing the Air We Breathe — The OpenSense Zurich Dataset,” in Proceedings of the Twenty-Sixth AAAI on Artificial Intelligence, Toronto, Ontario, Canada, 2012, pp. 323–325.
7. Puentes, John, Julien Montagner, Laurent Lecornu, and Jaakko Lahteenmaki, “Quality Analysis of Sensors Data for Personal Health Records on Mobile Devices,” in Pervasive Health Knowledge Management, Bali, Rajeev K., Indrit Troshani, and Steve Goldberg, Eds., New York, Springer, 2013, pp. 103-134.

Co-funded by the European Union

TOPIC DESCRIPTION CARD

Topic name: **3D scanning, process and device**

Number of hours per topic: 3 hours
Lectures
2 hours
Laboratory classes
1 hours

Responsible for the course/lecturer:

Assoc. Prof. Filip Górski, PhD., Eng.

email: filip.gorski@put.poznan.pl
Poznan University of Technology
Faculty of Mechanical Engineering

MEng Justyna Rybarczyk
email: Justyna.Rybarczyk@doctorate.put.poznan.pl
Poznan University of Technology
Faculty of Mechanical Engineering

Prerequisites

1 Knowledge:
- in scope of information technologies and technical drawing, CAD/CAM, manufacturing technologies,
- of orthopaedic and prosthetic supplies.

2. Skills:
- in solid modelling of an object in a CAD 3D system,
- designing an orthopaedic or prosthetic supply.

3. Social competences:
- cooperation in a project team,
- awareness of responsibility for assigned tasks,
- understanding the need for new knowledge.

Topic objective
The aim of course is to get familiarized with techniques and methods of automated design of orthopaedic and prosthetic products, using reverse engineering and KBE

and rapid manufacturing of these products using additive manufacturing technologies (3D Printing).

Topic-related learning outcomes

1 Knowledge:
- Describes the role of design in modern design engineering process.
- Describes technological foundations of additive technology of FDM and possibilities of its application in orthopaedics and prosthetics.
- Describes possibilities of design using reverse engineering and KBE.

2. Skills:
- Creates 3D models, prepares and processes a triangular mesh file (STL), selecting resolution for the needs of additive manufacturing
- Manufactures orthopaedic products using FDM technology. Prepares a batch file and selects parameters. Performs post processing.
- Processes triangular mesh and uses intelligent CAD models for generating a design of an orthosis/prosthesis.

3. Social competences:
- Is open to implementation of rapid manufacturing in engineering activities.
- Is able to develop knowledge on their own.
- Is able to work in a project team using rapid product development techniques.

Methods for verifying learning outcomes and assessment criteria

Partial marks:
a) lectures:
- on the basis of answers to questions regarding material from previous lectures,

b) laboratory:
- on the basis of evaluation of current advancement in realization of given tasks,

Summary mark:

a) lectures:
- evaluation of knowledge by written final test with open and closed questions; questions are assessed on a point scale, and to pass it is required to collect at least 50% of the total possible number of points

b) laboratory:
- evaluation of advancement in realization of project of a given orthosis/prosthesis,
- evaluation of results, e.g. obtained product and a summarizing report,
- to obtain a pass, it is necessary to present a report describing the completed project of the orthosis /prosthesis, containing description of at least 3 out of 4 stages of the process (these are: obtaining and processing patient data, obtaining the base 3D model of the orthosis / prosthesis, model improvement, manufacturing and assembly of the product)

Programme content

Lectures:
- mass customization in medical engineering - production of individualized supplies,
- reverse engineering techniques (3D scanning) in medicine - hardware, software, methodology of gathering and processing data,
- rapid manufacturing technologies - Fused Deposition Modelling in prosthetics and orthotics (basics, materials, applications, machines, software, planning and realization of a process, post processing),
- design automation techniques - basics of KBE (Knowledge Based Engineering) and auto-generating models in medical applications.

Laboratory - course:
- presentation of a process of rapid design and manufacturing of orthopaedic and prosthetic supplies in Laboratory of Rapid Manufacturing,
- division into 3-4 person groups, selection of a product (openwork hand orthosis, leg orthosis, hand prosthesis)

Teaching methods

- informative lecture
- multimedia presentation
- case study

Bibliography

Basic

1. F. J. Rybicki, G. T. Grant (Eds.), 3D Printing in Medicine: A Practical Guide for Medical Professionals, Springer 2017

2. Chua C. K., Leong K. F., and Lim C. S., 2010, “Rapid Prototyping: Principles and Applications”, World Scientific Publishing Co. Pte. Ltd., Singapore

Additional

1. Koh J., CATIA V5 Design Fundamentals A Step by Step Guide, ONSIA Inc., ISBN-13: 978-1477689028 ISBN-10: 1477689028

Co-funded by the European Union

TOPIC DESCRIPTION CARD

Topic name: Medical Imaging (CT/MRI/USG)

Number of hours per topic: 3 hours
Lectures
3 hours

Responsible for the course/lecturer:

lecturer PhD Candidate Diana Pavlova
Training and Development Specialist at SWISS Dentaprime, Bulgaria
Magdalena Parcheva PhD
Technical University of Varna, Bulgaria

Prerequisites

1 Knowledge:
Prospective students should have a basic understanding of the principles and applications of medical imaging modalities such as CT, MRI, and ultrasound. This includes a basic knowledge of the physical principles underlying each modality, their typical clinical uses, and the differences in imaging capabilities between them.

2. Skills:
Students should possess skills in interpreting medical images. Proficiency in the use of imaging software for image analysis and manipulation is essential.

3. Attitude:
Students must possess the effective communication skills necessary to convey imaging findings to healthcare professionals and patients in a clear and understandable manner. They must be able to work collaboratively in multidisciplinary teams, respecting diverse perspectives, and contributing to discussions about diagnostic and treatment strategies involving medical imaging. Students must maintain an ethical awareness and adhere to patient confidentiality and safety protocols in medical imaging practice.

Topic objective

This topic aims to provide a comprehensive survey of medical imaging technologies – computed tomography (CT), magnetic resonance imaging (MRI) and ultrasound (Echography). These modalities have revolutionized diagnostic capabilities in healthcare, offering a detailed view of human anatomy and pathology. The module delves into the basic principles, various applications and recent advances in CT, MRI and ultrasound imaging. It emphasizes the integration of these technologies into clinical practice, highlighting their role in diagnosis, treatment planning and therapeutic monitoring in various medical disciplines. Students will gain a thorough understanding of imaging principles, technical competence, safety protocols and ethical considerations that are essential for the effective use and interpretation of medical images in healthcare settings.

Topic-related learning outcomes

1 Knowledge:

- Students show a comprehensive understanding of the principles underlying Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and Ultrasound (USG) modalities, including the physical phenomena and techniques involved.
- Students familiarize themselves with imaging protocols, acquisition techniques, and optimization strategies to ensure the acquisition of accurate and high-quality medical images.
- Students know safety protocols, radiation dose optimization techniques, and ethical considerations associated with the use of CT, MRI, and contrast agents.
- Students understand the importance of interdisciplinary collaboration and effective communication in conveying imaging findings to healthcare professionals, facilitating prompt and accurate clinical decision-making.
- Students appreciate the role of medical imaging in patient care, including its impact on diagnosis, treatment planning, and monitoring of therapeutic interventions.
- Students recognize the significance of continuous professional development and lifelong learning in keeping pace with advancements in medical imaging and contributing to the advancement of healthcare.
- Students develop a patient-centric approach, demonstrating empathy, attention to detail, and professionalism in the delivery of imaging services and patient interactions.

2. Skills:

- Students interpret and analyze medical images: Develop expertise in interpreting CT, MRI, and USG images to identify anatomical structures, detect abnormalities, and make diagnostic assessments. Apply critical thinking and analytical skills to analyze imaging findings in correlation with clinical information for accurate diagnoses.

- Students utilize imaging findings for diagnosis and treatment planning: Apply imaging findings to formulate diagnoses, generate differential diagnoses, and develop appropriate treatment plans in collaboration with other healthcare professionals. Understand the limitations and strengths of different imaging modalities in specific clinical scenarios.
- Students communicate and report imaging results effectively: Effectively communicate imaging findings to healthcare professionals through clear and concise reports, ensuring accurate and relevant information is conveyed for clinical decision-making. Develop skills in conveying complex imaging concepts to non-experts in a patient-friendly manner.
- Students practice radiation safety and optimize imaging protocols: Adhere to radiation safety guidelines and implement dose optimization techniques to minimize radiation exposure to patients and healthcare providers. Understand the principles of radiation protection and apply appropriate imaging protocols based on patient-specific factors.
- Students collaborate in a multidisciplinary team: Work collaboratively with radiologists, clinicians, and other healthcare professionals to discuss imaging findings, contribute to diagnostic and treatment discussions, and provide valuable input in complex cases. Effectively communicate and share knowledge to facilitate optimal patient care.
- Students adapt to new imaging technologies and advancements: Stay updated with the latest developments in medical imaging, including new technologies, software updates, and research findings. Continuously expand knowledge and skills to adapt to evolving imaging techniques and apply them effectively in clinical practice.

3. Attitude:
   - Students use patient-centric approach: develop a deep appreciation for the importance of patient care and empathy in medical imaging. Show compassion, respect, and sensitivity towards patients during imaging procedures, considering their comfort and well-being as a priority.
   - Students foster a commitment to accuracy and attention to detail: Understand the critical role of accuracy in medical imaging for proper diagnosis and treatment planning. Cultivate a meticulous and detail-oriented mindset to ensure precise image acquisition, interpretation, and reporting.
   - Students embrace a problem-solving mindset: Develop a proactive and analytical approach to complex imaging scenarios. Demonstrate the ability to identify challenges, think critically, and seek innovative solutions to optimize imaging outcomes and enhance patient care.
   - Students cultivate a growth mindset: Embrace a mindset of continuous learning and improvement. Demonstrate openness to new technologies, techniques, and research findings, actively seeking opportunities for professional development and staying updated with advancements in medical imaging.

- Students promote interdisciplinary collaboration: Recognize the value of teamwork and effective communication in healthcare settings. Collaborate seamlessly with other healthcare professionals, understanding the contributions of each discipline and fostering an environment of mutual respect and cooperation.
- Students maintain professionalism and ethical behavior: Uphold professional ethics, integrity, and confidentiality in all aspects of medical imaging practice. Shows professionalism in interactions with patients, colleagues, and other healthcare professionals, displaying professionalism, reliability, and accountability.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:
- Lectures
-on the basis of answers to the questions regarding material from previous lectures

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Assessment scale:
Lectures:
--evaluation of knowledge by a written final test with open and closed questions, questions are assessed on a point scale, and to pass is required to collect at least 50% of the total possible number of points

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Programme content

1. Medical Imaging (CT, MRI, and USG) in general.
2. Importance of Medical Imaging.
3. Significance of Understanding Medical Imaging Principles.
4. Interdisciplinary Cooperation.
5. Clinical Integration and Patient Health Care.
6. Technical Proficiency.
7. Applications and Advancements.

Teaching methods
- Monological (lecture, instruction)
- Dialogic (Discussion, conversation, brainstorming)
- Demonstration
- Lecturing
- E-learning

- Methods of working with the text (study book, book)
- Individual work of students
- Teamwork
- Practice exercises

Bibliography

Basic

1. Abdelkarim A. Cone-Beam Computed Tomography in Orthodontics. Dentistry Journal. 2019; 7(3):89. https://doi.org/10.3390/dj7030089
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3. Weiss R II, Read-Fuller A. Cone Beam Computed Tomography in Oral and Maxillofacial Surgery: An Evidence-Based Review. Dentistry Journal. 2019; 7(2):52. https://doi.org/10.3390/dj7020052
4. Spagnuolo G. Cone-Beam Computed Tomography and the Related Scientific Evidence. Applied Sciences. 2022; 12(14):7140. https://doi.org/10.3390/app12147140
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A Literature Review. Journal of Imaging. 2021; 7(5):75. https://doi.org/10.3390/jimaging7050075

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Co-funded by the European Union

TOPIC DESCRIPTION CARD

Topic name: **Application of the 3D images for designing as a function of the processing technology (digital tools for designing)**

Number of hours per topic: 3 hours
Lectures
2 hours
Laboratory classes
1 hours

Responsible for the course/lecturer:

Assoc. Prof. Filip Górski, PhD., Eng.

email: filip.gorski@put.poznan.pl
Poznan University of Technology
Faculty of Mechanical Engineering

MEng Justyna Rybarczyk
email: Justyna.Rybarczyk@doctorate.put.poznan.pl
Poznan University of Technology
Faculty of Mechanical Engineering

Prerequisites

1 Knowledge:
- in scope of information technologies and technical drawing, CAD/CAM, manufacturing technologies,
- knowledge of medical imaging technologies; knowledge of medical products: orthopaedic and prosthetic equipment, implants, rehabilitation devices etc.

2. Skills:
- in solid modelling of an object in a CAD 3D system
- designing a medical device

3. Social competences:
- cooperation in a project team
- awareness of responsibility for assigned tasks

- understanding the need for new knowledge

Topic objective

The aim is to get familiarized with techniques and methods of automated design of individualized medical products, such as implants, prostheses, orthoses or rehabilitation devices, with use of knowledge engineering and intelligent CAD models.

Topic-related learning outcomes

1 Knowledge:
Describes role of design in modern design engineering process. Describes possibilities of design of individualized medical products using medical imaging techniques and 3D scanning. Describes possibilities of automation of design of medical products with use of knowledge engineering and intelligent CAD models

2. Skills:
- Creates 3D models of individualized medical products on the basis of medical imaging/3D scanning data.
- Prepares intelligent CAD models of individualized medical products with use of KBE techniques and uses these models to generate projects of medical products for specific patients.

3. Social competences:
- Is open to implementation of advanced CAD systems in biomedical engineering.
- Is able to develop knowledge on their own.
- Is able to work in a project team using digital technologies.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:
Partial marks:
a) lectures:
- on the basis of answers to questions regarding material from previous lectures,
b) laboratory:
- on the basis of evaluation of current advancement in realization of given tasks.

Assessment scale:

a) lectures:
- evaluation of knowledge by written final test with open and closed questions; questions are assessed on a point scale, and to pass it is required to collect at least 50% of the total possible number of points
b) laboratory:
- evaluation of progress in realization of laboratory exercises

- evaluation of results of a final assessment - an own intelligent model of a selected medical product
- to obtain a pass, it is necessary to complete all laboratory exercises (attendance + follow the instructions provided) and present to the tutor an own intelligent model, which will be assessed on a point scale (points are awarded for: compliance with the subject of the classes, functionality, degree of automation and resistance to errors) - it is necessary to obtain at least 50% of the points

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Programme content

Lectures:
- design of individualized medical products on the basis of medical imaging technologies and 3D scanning
- design automation techniques - basics of KBE (Knowledge Based Engineering) and auto-generating models in medical applications.

Laboratory - course:
- processing of medical imaging data and 3D scanning data (computer laboratory)
- design of selected medical products on the basis of medical imaging data (2-3 examples: orthoses and prostheses)

Teaching methods

- informative lecture
- multimedia presentation
- laboratory method

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2. F. J. Rybicki, G. T. Grant (Eds.), 3D Printing in Medicine: A Practical Guide for Medical Professionals, Springer 2017

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1. Chua C. K., Leong K. F., and Lim C. S., 2010, “Rapid Prototyping: Principles and Applications”, World Scientific Publishing Co. Pte. Ltd., Singapore

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Co-funded by the European Union

TOPIC DESCRIPTION CARD

Topic name: **Medical equipment, hospital equipment**

Number of hours per topic: 4 hours
Lecture: 2 hours
Tutorials: 2 hours

Responsible for the course/lecturer:

Katarína Monková

Prerequisites

1 Knowledge:
- Mastering the basics of machine structures;
- Mastering the methods and means of technical and experimental research of machines as well as the means of controlling machines and processes.

2. Skills:
- Ability to use professional terminology and process technical documentation;
- Ability to read technical drawings of products or parts and propose the most efficient methods and procedures for their production;
- Ability to perform assembly, surface treatments, packaging and shipping;
- Ability to perform expert analysis of machinery and production technologies;
- Ability to analyse and evaluate technical solutions;

3. Social competences:
- None

Topic objective

The subject follows the basic competencies on complex design of mechanisms and machines.
The aim of the subject is to develop knowledge and skills in the field of technical, ergonomic and user aspects of medical and hospital equipment for implantology and prosthesis.
An important part of the education is the student's independent work focused on analyse of the selected equipment and suggestion of improving the design or functionality.

Topic contents

The medical and hospital equipment (M&HE) regulations and standards
M&HE designing, manufacturing and maintenance processes

Topic-related learning outcomes

1 Knowledge:
- Understanding medical and hospital equipment regulations and standards
- Understanding the principles of the basic medical and hospital equipment for implantology and prosthesis.

2. Skills:
- Ability to analyse technical, ergonomics and utilization properties of medical and hospital equipment for implantology and prosthesis;
- Ability to improve the properties of medical and hospital equipment for implantology and prosthesis.

3. Social competences:
- Ability to work independently on simple analytical and synthetical task of improvement of medical and hospital equipment for implantology and prosthesis.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:
Analyse of student performance on:
- Complex analyses of the medical and hospital equipment for implantology and prosthesis.
- Suggestion of improvement of the medical and hospital equipment for implantology and prosthesis.

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Assessment scale:
Lectures:
--evaluation of knowledge by a written final test with open and closed questions, questions are assessed on a point scale, and to pass is required to collect at least 50% of the total possible number of points

Programme content

1. Basic medical and hospital equipment (M&HE) regulations and standards
2. Reliability of the M&HE
3. Specifications a designing of the M&HE
4. M&HE testing and data analysis

5. M&HE manufacturing and maintenance processes…

Teaching methods

Lecturing
Dialogic (Discussion, conversation, brainstorming)
Practice exercises
Dealing with situational issues - learning in situations
Individual work of students

Bibliography

Basic

1. Fries R.C.: Reliable design of medical devices, 2006, CRC Press, Boca Raton, ISBN 0-8247-2375-9
2. Becchetti C., Neri A.: Medical instrument design and development from requirements to market placements, 2013, John Wiley and Sons Ltd., ISBN 987-1-119-95240-4

Additional

1. Webster J.G.: Encyclopedia of medical devices and instrumentation *in 6 volumes*, 2006, John Wiley and Sons Ltd., New Jersey, ISBN
2. Boutrand J-P.: Biocompatibility and performance of medical devices, 2012, Woodead Publishing Limited, ISBN 978-0-85709-070-6

Co-funded by the European Union

TOPIC DESCRIPTION CARD

Topic name: Introduction: Integrating exercise

Number of hours per topic: 3 hours
Lectures
3 hours

Responsible for the course/lecturer:

Associate Professor Tünde Anna Kovács
Email: kovacs.tunde@bgk.uni-obuda.hu
Óbuda University
Bánki Donát Faculty of Mechanical and Safety Engineering

Prerequisites

1 Knowledge:
-knowledge of the biocompatible and biomaterials properties
-knowledge of the processing technologies of the biomaterials and biocompatible materials
-knowledge of 3D printing of the metals, ceramics and polymers
-knowledge of the anatomy of the implantology
-knowledge of the material selection for implant
-knowledge of the databases, programming, AI
-knowledge of the medical imaging (CT/MRI/USG)
-knowledge of the 3D images for designing as a function of the processing technology
knowledge of the medical equipment, hospital equipment

-
2. Skills:
-basic skills in the operation of CAD designing
-skill in material selection for implant
-skill in database application
-skill in medical imaging
-communication skills
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3. Attitude:

- student understands the need of gathering new knowledge and skills
- student can self-develop new skills and knowledge
-student understand the benefit of the implantology
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Topic objective

The aim of “Integrating exercise” summarizes the knowledge acquired during the course. Through a case study, it summarizes the patient from consultation with the doctor to recovery. The student already knows all the steps required for proper implant designing and manufacturing. The student should be able to make his own implant with the knowledge.

Topic-related learning outcomes

1 Knowledge:
-Students understand the health care system communication.
-Describe the implantology process steps
- Know the telemedicine system, medical informatics

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2. Skills:
-skills in operation of computer system
-skills to design implant included all steps
-skill to apply the telemedicine system, medical informatics
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3. Attitude:
- student understands the need of gathering new knowledge and skills
- student can self-develop new skills and knowledge
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Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:
- Lectures:
-on the basis of answers to the questions regarding material from previous lectures

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Assessment scale:
Lectures:
--evaluation of knowledge by a written final test with open and closed questions, questions are assessed on a point scale, and to pass is required to collect at least 50% of the total possible number of points

Programme content

Case study for summarising the course knowledge
-Communication with the patient
-Problem definitions
    missing tooth (anatomy knowledge)
    medical imaging (CT/MRI/USG)
-Steps of the implantology
    -telemedicine system, medical informatics
    -designing of the implant
    -material selection
    -final treatment of the implant
-Operation
    -implantation
    -recovering and health care
    -control of the recovered patient
-Communication with the patient
    aftercare
    life with implant

Teaching methods
Informative lecture
Multimedia presentation

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2. J.M. Anderson, 4.2 Biocompatibility and the Relationship to Standards: Meaning and Scope of Biomaterials Testing, Editor(s): Paul Ducheyne, Comprehensive Biomaterials II, Elsevier, 2017, Pages 7-29, ISBN 9780081006924, https://doi.org/10.1016/B978-0-08-100691-7.00108-7.
3. Jack E. Lemons, Dental Implant Biomaterials, The Journal of the American Dental Association, Volume 121, Issue 6, 1990, Pages 716-719, ISSN 0002-8177, https://doi.org/10.14219/jada.archive.1990.0268.

Additional

1. Osman RB, Swain MV. A Critical Review of Dental Implant Materials with an Emphasis on Titanium versus Zirconia. Materials 2015, 8, 932-958
2. Wang, SH., Hsu, JT., Fuh, LJ. et al. New classification for bone type at dental implant sites: a dental computed tomography study. BMC Oral Health 23, 324 (2023). https://doi.org/10.1186/s12903-023-03039-2