TEHNIKA I INFORMATIKA U OBRAZOVANJU
3. Internacionalna Konferencija, Tehnički fakultet Čačak, 7–9. maj 2010.
TECHNICS AND INFORMATICS IN EDUCATION
3rd International Conference, Technical Faculty Čačak, 7–9th May 2010.

UDK: 61:659.2 Uvodni referat

BIOMEDICAL ENGINEERING STUDIES IN POLITEHNICA UNIVERSITY OF TIMISOARA

Mirela Toth-Tascau [1]

***Summary**: Healthcare reform in Romania needs specialists to discover, develop, promote and exploit innovative products and services that can help with physicians to improve quality of life and to meet the expectations and demands of patients. Medical Engineering Specialization - Bachelor program - is one of the newest specialties of the Faculty of Mechanical Engineering in politehnica University of Timisoara. Educational mission of "Medical Engineering" specialization is to train specialists with interdisciplinary knowledge, competitive nationally and internationally, with specific engineering and medical skills.*

***Key words:** Bachelor Programme, Biomedical Engineering specialization, curriculum, interdisciplinary field*

STUDIJE BIOMEDICINSKOG INŽENJERSTVA NA POLITEHNIČKOM UNIVERZITETU U TEMIŠVARU

***Rezime**: Reforma zdravstva u Rumuniji zahteva postojanje stručnjaka koji će otkriti, razviti, potpomagati i istraživati inovativne proizvode i usluge koji bi pomogli lekarima da poboljšaju kvalitet života i izađu u susret očekivanjima i zahtevima pacijenata. Specijalizacija u Medicinskom Inženjerstvu – program za sticanje diplome prvog stepena – jedan je od najnovijih osobenosti na Fakultetu za Mehaničko Inženjerstvo Politehničkog Univerzitea u Temišvaru. Obrazovna misija specijalističkih studija „Medicinskog Inženjerstva" je upoznavanje stručnjaka sa znanjem iz raznih disciplina i sa posebnim inženjerskim i medicinskim veštinama.*

***Ključne reči:** Program za dobijanje diplome prvog stepena, specijalizacija u Biomedicinskom Inženjerstvu, nastavni program, interdisciplinarno polje proučavanja*

1. INTRODUCTION

Biomedical Engineering is an interdisciplinary field in which the principles, laws, and techniques of engineering, physics, chemistry, and other physical sciences are applied to facilitate progress in medicine, biology, and other life sciences. Biomedical engineering

[1] Professor Ph.D. Mirela Toth-Tascau, Politehnica University of Timisoara, Faculty of Mechanical Engineering, Timisoara, Bd. Mihai Viteazu No 1, E-mail: mirela@cmpicsu.upt.ro

encompasses both engineering science and applied engineering in order to define and solve problems in medical research and clinical medicine for the improvement of health care. Biomedical engineers must have training in anatomy, physiology, and medicine, as well as in engineering.

Biomedical Engineering develops new equipments for investigation, therapy, monitoring and laboratory used in Biology and Medicine, as well as principles, methods and techniques underlying the operation of such equipments. Biomedical engineering creates functional models, medical equipments, implants, prostheses and orthoses, assistive devices, organ enhancers and artificial organs, medical robots. Engineering's new medical fields consist of medical robotics and telemedicine. Also, medical engineering involves not only the production of biomedical equipments, but also use these devices in terms of medical quality and safety both for patient and medical personnel.

The modern equipments and advanced techniques used in medical care institutions require qualified personnel able to manage with them: installation and utilization, assistance for many operations and procedures, development of standard performances, maintenance, etc [1]. Biomedical engineers require up-to-date knowledge of best practices for managing and maintaining medical equipment. Thus, companies and research institutes specialised in research, design, manufacturing and marketing of medical devices are interested in a highly trained, multidisciplinary qualified personnel.

On a national scale, in hospitals, private clinics, research and educational institutions, technical medical schools, or technical assistance and governmental organisms for medical instrumentation regulations and specifications, there is a major need for biomedical engineering specialists [1]. In order to respond to this demand, consistent educational programmes in biomedical engineering are needed.

A recent survey of the current trends and effectiveness of the educational process towards career oriented goals shows that the biomedical engineering professional education has to rely on the modern engineering curricula, yet to be focused on specific aspects of biomedical engineering. This approach corresponds also to the national goal of integration in the European academic and career-related policies and structures [1].

The evolving European Higher Education Area will substantially influence the development of medical and biological engineering and sciences. These developments will be beneficial to the biomedical engineering profession and to The society as a whole. The biomedical engineering community must grasp this opportunity through focused national and European actions and cooperation with the relevant bodies [2].

2. ROLE OF ARACIS AND ROMANIAN SCIENTIFIC SOCIETIES IN HIGHER EDUCATION

The Romanian Agency for Quality Assurance in Higher Education (ARACIS) was established in 2005 and is an autonomous public institution, of national interest, whose main mission is the external evaluation of the Romanian higher education’s quality, at the level of study programmes, as well as from the institutional point of view [3].

ARACIS is a full member of the European Association for Quality Assurance in Higher Education – ENQA and is registered in the European Quality Assurance Register for

Higher Education - EQAR. The agency's strategy reflects the mission assumed by ARACIS in order to constantly assure and improve quality in the Romanian higher education. The Agency is carrying out its activity according to the best international practices, which are taken in its own Methodology and whose implementation is focused towards quality assurance and evaluation of the Romanian higher education, as part of the European Higher Education Area [3].

In the development of research and higher education, an important role is played by the Romanian scientific societies, such as: Romanian Society of Medical Engineering and Biological Technology and Romanian Society for Biomaterials.

Romanian Society of Medical Engineering and Biological Technology is involved both in promotion of biomedical engineering in Romania and in the education and training of the individuals engaged in Biomedical Engineering and science. As a technical, scientific and interdisciplinary organisation, the association has the following aims and objectives [4]:

- it participates in the development and implementation of the policy of stimulation of biomedical engineering in Romania;
- collaborates in the coordination of professional training of engineers and technicians in the field of biomedical engineering;
- stimulates the creative scientific initiative in the field of medical and biological engineering;
- stimulates international collaboration and cooperates with similar national and international associations for the development of biomedical science and technology.;
- participates in the improvement of the curricula for the education of those interested in biological and medical engineering.

Romanian Society for Biomaterials has the following main objectives [5]:

- to regularly review the dynamics of biomaterials used in Romania, to table the legislative and executive institutions, coordinate and / or to execute national programs and / or research topics related to procurement, testing, processing and use of biomaterials and biomaterials applications;
- to participate in the development of normative technical documents, standards and legislative proposals related to biomaterials and related areas of interest;
- to contribute to improving the training of its members in biomaterials and biomaterials applications;
- to facilitate a broad exchange of experience, knowledge and ideas both within the association, and between it and other national and international organizations.

In addition to these scientific societies, there are many research centres at national or university level that are involved in the development of the biomedical engineering education.

3. OBJECTIVES AND TOPICS OF THE BIOMEDICAL ENGINEERING STUDY PROGRAMME IN POLITEHNICA UNIVERSITY OF TIMISOARA

Biomedical engineers must have training in anatomy, physiology, and medicine, as well as in engineering. Anyone employed in the biomedical engineering field will need at the least a bachelor's degree in engineering. In addition to studying the required background courses of mathematics and physical and life sciences, a biomedical engineer will also need special coursework in the biomedical area.

The studies in Politehnica University of Timisoara are organized in “Bologna” paradigm and comprise all the three cycles: Bachelor, Master, and Doctorate. The duration of the bachelor university studies is 4 years for the fundamental field “Engineering Sciences”. The bachelor studies in Politehnica University of Timisoara are structured in two stages: Stage I, including study years I-II, and Stage II, including study years III–IV for the fundamental field “Engineering Sciences” [6].

Mechanical Engineering Faculty of Politehnica University of Timisoara has a rich portfolio of expertise, both for Bachelor and Master studies. One of the interdisciplinary fields, vanguard, offered by the Faculty of Mechanical Engineering those who opt for the engineering profession is Medical Engineering. Specialization Medical Engineering is one of the new specialities of the Faculty of Mechanical Engineering, in 2009 year having the third series of graduates.

In the nomenclature of Bachelor's degree areas, "Medical Engineering" specialization is part of the fundamental domain "Engineering Sciences", domain "Applied Engineering Sciences".

Educational mission of Medical Engineering Specialization is to train specialists with interdisciplinary knowledge, competitive nationally and internationally, with specific engineering and medical skills. Skills training considering cognitive, practical-applicative, and communication and relationships aspects are being structured as follows:

- general knowledge of specific engineering profession;
- modeling of biological systems and model implementation in medical investigation;
- conception, design, construction, operation and development of modern medical equipments;
- expertise, technical advice and service for the operation and development of medical equipments;
- conception, design, development and use of medical informatics applications;
- acquisition and processing of biomedical signals and images;
- conception, design, manufacture and testing of dental and orthopedic implants and prosthetic and orthoses elements;
- selection and use of biomaterials to manufacture the medical devices;
- quality assurance and maintenance of medical devices;
- implementation of modern medical equipments and management of medical entities.

The abilities and knowledge assessed by the students are presented in Table 1.

Table 1: Abilities and knowledge

Category	Abilities and knowledge
Fundamentals	Understanding and appliance of fundamental knowledge in mathematics, physics, chemistry, measurement techniques, material science, graphics, mechanical engineering, electrical and electronics engineering, applied informatics and automation
	Computer - aided design and application of specialized software
	Communication skills, team work, interdisciplinary cooperation and innovation
	Knowledge and appliance of fundamentals in legislation, economy, management, marketing and quality assurance
Domain	Knowledge from side disciplines, associated with Medical Engineering (engineering issues, functional anatomy and physiology, biochemistry)
	Biological systems modelling, analysis of biomechanical structures and model implementation in medical investigations (biological systems modelling, biomaterials, biomechanics)

	Design, programming, manufacturing, optimization, testing, using and maintenance of medical apparatus and equipments (assisted design, design elements, materials used in medical applications, optic equipments, medical apparatus/equipments, reliability and ergonomics)
	Hardware and software control of medical equipments, conception, developing and utilization of medical informatics (programming, medical informatics, medical data basis, expert systems, artificial intelligence, medical electronics)
Specialization	Signals and medical image processing (image acquisition and processing, investigation techniques, medical imaging techniques and equipments)
	Conception and fabrication of implants, prostheses and orthoses elements (dental, maxillofacial and orthopedic implants, stabilization and substitution elements, prostheses, orthoses, medical robotics).

Every semester, 14 weeks are designated essentially to conveying knowledge and training skills and 4 weeks are exclusively allocated to assessment of knowledge and skills.

The total student workload per semester is transposed into credit points so that, at the level of disciplines planned for the respective semester, in compliance with the regulations defined and promoted by the European Union on, it would sum up to 30 credits.

After a common-core courses for two years, students can opt for elective and packages of elective courses according to their specialisation. Individual Medical Engineering courses are presented in Table 2.

Table 2. Disciplines in 3rd and 4th years of study

III Year	
Compulsory	**Elective - independent**
- Medical electronics - Computer aided design - Elements of fine mechanics - Manufacturing of Medical devices - Acoustics and hearing prostheses - Biomechanics - Medical optics and optical equipments - Management - Marketing - Student practice	- Composite materials for medical applications / Sinterized materials for medical applications - Sensors and sensorial systems / Biosignals and biosignal processing - Medical informatics / Informatic systems in diagnosis - Image acquisition and processing / Acquisition systems, interfaces and virtual instrumentation
IV Year	
Elective - independent	**Elective - package**
- Devices and equipments for medical investigation / Equipments for laboratory tests - Medical robotics / Dental and orthopaedic implantology - Numerical analysis of biomechanical structures / Finite element method - Apparatus and equipments for therapy / Medical instruments / Surgical unit - Ortheses and prostheses / Rehabilitation and prosthetic engineering - Techniques and equipments for medical imaging / Biometric investigation techniques / Advanced techniques in medicine - Databases and expert systems for medical applications / Software engineering in medical informatics	- Reliability of medical equipments - Quality assurance of medical devices - Mathematical statistics and experimental data processing - Ergonomics of medical devices - Logistics of medical departments - Quality management of testing laboratories - Applied statistics in medical engineering - Terotechnics of medical devices

Specialized subjects are taught by professors from the Politehnica University of Timisoara, having experience and outstanding results in Medical Engineering. Student education is supplemented with medical nature subjects (*Anatomy and physiology, Biochemistry, Tissue engineering, Surgical techniques of implantation*), taught by professors from the University of Medicine and Pharmacy "Victor Babes" Timisoara.

Speciality practice of students is conducted in hospitals, based on concluded agreements (Emergency County Hospital Timisoara - I Orthopaedic Clinic, Military Emergency Hospital Timisoara).

Students in Medical Engineering Programme benefit by scholarships for studies or diploma projects and to participate in specialized intensive courses in various universities abroad.

It is necessary to pass all courses mentioned above for obtaining a certificate on Medical Engineering study. Moreover, it is necessary to pass the Medical Engineering Diploma Thesis.

The graduate is awarded the Bachelor of Medical Engineering (BME) degree and thus he becomes a MEDICAL BIOENGINEER.

Job titles can vary depending on the exact nature of the work. Work activities vary, depending on where the graduates work and the seniority of the post [7]:

- using computer software and mathematical models to design, develop and test new materials, devices and equipment;
- conducting research to solve clinical problems using a variety of means to collate the necessary information, including questionnaires, interviews and group conferences;
- liaising closely with other medical professionals, such as doctors and therapists as well as with end-users;
- discussing and solving problems with manufacturing, quality, purchasing and marketing departments;
- dealing with technical queries from hospitals and giving advice on new equipments;
- testing and maintaining clinical equipments;
- training technical or clinical staff;
- keeping up to date with new developments in the field, nationally and internationally.

4. CONCLUSIONS

Healthcare reform in our country needs specialists to discover, develop, promote and exploit innovative products and services that can help with physicians to improve quality of life and to meet the expectations and demands of patients. Modern medical equipments enjoy a spectacular progress that is not possible without specialists in Medical Engineering.

Bioengineering and biotechnology are exploding - the number of career opportunities is expected to increase twice as fast as for other science and engineering fields over the next decade. Bioengineers and biotechnologists have enormous potential to meet employment needs ranging from traditional careers in science and engineering through a host of alternative career pathways [8].

Some biomedical engineers also have advanced training in other fields. For example, many biomedical engineers also have an Master or Doctoral degree, thereby combining an understanding of advanced technology with direct patient care or clinical research.

5. REFERENCES

[1] R.V. Ciupa, Biomedical Engineering Education in Romania. Biomedical Engineering Education in Europe – Status Reports, http://www.biomedea.org/documents.htm, BIOMEDEA, 2005
[2] http://www.biomedea.org/biomedea.htm
[3] http://www.aracis.ro
[4] http://www.snimtb.ro
[5] http://www.srb.ro
[6] http://www.upt.ro/english/pdf/RODPI_UPT_2008_en.pdf
[7] http://www.prospects.ac.uk/p/types_of_job/biomedical_engineer_job_description.jsp
[8] G. Madhavan, B. Oakley, L. Kun (Eds.), *Career Development in Bioengineering and Biotechnology,* IFMBE Series: Series in Biomedical Engineering, 2009.