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FABRICATION OF MEDICAL DEVICES

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***Summary**: The paper presents the extended content of the curriculum for the course named Fabrication of the medical devices, and the benefits of achieving this course in enlargement of the student's employment perspective. The course is provided in 5th semester in the Curriculum of Medical Engineering specialization, in Politehnica University of Timisoara, Romania.*

***Key words:** Medical device, manufacturing, advanced technology, CNC programming.*

PROIZVODNJA MEDICINSKIH UREĐAJA

***Rezime:** U radu je predstavljen proširen sadržaj nastavnog programa za predmet Proizvodnja medicinskih uređaja, i prednosti uvođenja ovog programa zbog kreiranja brojnijih perspektiva studenata za zaposlenje. Postojanje ovog predmeta je omogućeno u petom semestru prema nastavnom planu specijalističkih studija Medicinskog Inženjerstva, na Politehničkom Univerzitetu u Temišvaru u Rumuniji.*

***Ključne reči:** medicinski uređaji, proizvodnja, razvijena tehnologija, CNC programiranje*

1. INTRODUCTION

The actual dynamics of the society imposes forming of highly adaptable personnel. The adaptability of a mechanical engineer in the working field comes under both his skills and abilities achieved during studies, trainings and self experience. Due to the constant technological developments and the changing in perspective of object manufacturing, a course achieved in the Bachelor Programme will be not enough. Continuous trainings are mandatory for maintaining the top level qualification together with the possibility to adapt in the working field.

The presented course is offered to the students on the 5th semester of the Bachelor Programme on Medical Engineering Specialization. This study programme is active in Mechanical Engineering Faculty of the POLITEHNICA University of Timisoara.

In order to elaborate the syllabus of the course, recent technical bibliography has been studied, together with the European standards regarding the development of the student's skills and abilities. The literature refers to machine architecture, CNC programming, classical and advanced technologies [1], [2], [3].

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2. COURSE INFORMATION

The presented discipline has 2 hours per week for lectures and other 2 hours per week for laboratory. At the end of the teaching period is provided an exam, having assigned 4 ECTS Credits. The student's evaluation is made upon a written paper work, the final mark being calculated in relation with the laboratory activity, in percentage of 50 %.

In order to understand the contents of this course, there are necessary the following prerequisites:

- Knowledge about 3D and 2D CAD design;
- Computer skills and abilities in technical field;
- Knowledge about measuring techniques;
- Knowledge in Biomaterial Science;
- Basics knowledge in Classical Mechanics;
- Basics knowledge regarding the functional anatomy of the human skeleton;
- Tolerances, dimensions and shape deviations.

In order to assure an international compatibility, the discipline syllabus was established taking into account syllabi of some similar courses taught in other universities, such as: California University of Pennsylvania [4], University of Virginia [5], and Technical University of Munich [6].

The lectures are taught using modern techniques such as video projector and internet. The students receive the course support both in electronic format and print material. In addition, they can study the recommended bibliography available in university library.

3. COURSE DESCRIPTION AND OBJECTIVES

The course has two main purposes: to transmit basic knowledge about fabrication, mandatory knowledge for any mechanical engineer, and to develop advanced abilities for students in the fabrication of medical devices field. At the end of the course the students have to achieve the following technological abilities:

- Knowledge of main fabrication technologies;
- Writing of NC programs;
- Understanding the architecture of the machine tools used in different applications;
- Providing optimal technological solutions for fabrication of the medical devices.

The specific abilities of the students will be:

- CAM design of prosthetic mechanical elements;
- Dental, maxillofacial and orthopedic implants fabrication.

The content of the course can be divided in two parts, accordingly with its two purposes. The first part of the course transmits basic information about the main categories of technology. This has the reason to develop basic technological skills of the students. With the first part of the course in background, the second part approaches specific issues in medical device manufacturing. This part focuses on development the abilities of the students. The main chapters of the course are:

- Basic machining technologies: lathing, milling, drilling and boring, grinding, broaching;
- Basic forming technologies: die casting, extrusion, forging, cold rolling, bending;

- Advanced technologies: Laser cutting and welding, wire and solid electro-erosion, rapid prototyping;
- Machine tools architecture. Coordinate systems, axes and origins;
- G code programming I and II;
- Specific technologies for Medical device fabrication: process, machine, tools, adaptations and manufacturing strategies.

The main topics and schedule of the chapters are presented in *Fig. 1*.

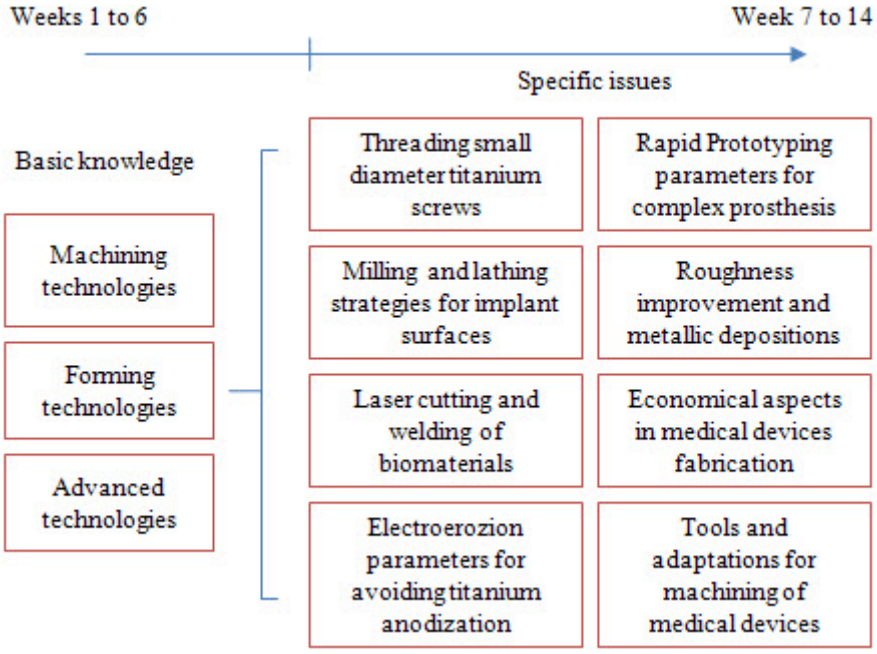

Figure 1: *Main topics involved in the chapters*

The applications mainly follow the course's chapters and are also divided in two parts. The first part corresponds to CAM modeling, writing of a NC program and validation of the program in simulation environments. The experimental part of the applications consists of identification of the machines architecture, machine operation and fabrication itself. The application issues are:

- NC programming;
- CNC machines architecture;
- Lathing machine operation;
- Milling machine operation;
- Wire electro-erosion operation;
- Plastic powder rapid prototyping;
- Metallic powder rapid prototyping.

The schedule of the applications is presented in *Fig.2*.

4. EMPLOYMENT IMPACT

By submitting, taking part at the theoretical and practical activities and passing the examinations of this course, the students will develop their skills and abilities in manufacturing field. This represents a great achievement for an engineer, increasing its chances of employment in the working field. The activities that can be performed by an engineer having passed this course are:

- Production activities:
  - CAM design of medical devices;
  - NC code programming;
  - CNC machine operation and maintenance;
  - Technological solutions for optimal manufacturing conditions;
  - Supervision of the manufacturing processes.
- Research activities:
  - New technologies in fabrication of medical devices;
  - Optimal manufacturing solutions for biomaterials;
  - Surface technology.

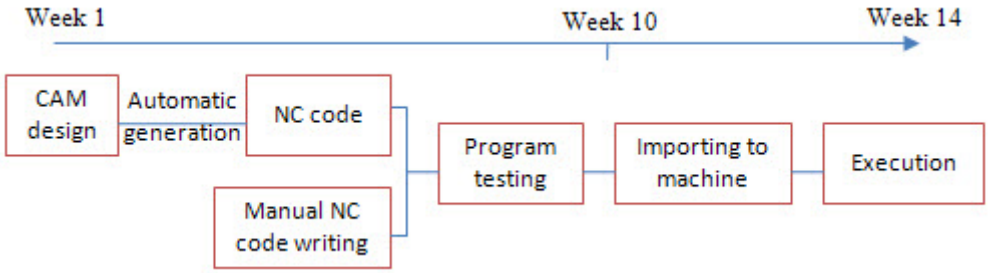

Figure 2: *Schedule of the application topics*

5. CONCLUSIONS

The paper presents an extended syllabus of the discipline Fabrication of Medical Devices, underlining the importance of attending this course during the Bachelor Programme on Medical Engineering Specialization. The skills and abilities achieved by the students during this course will play an important role in finding and addapting to a working place in industry, research or education. It has to be mentioned that for keeping up with newest technological developments, follow up trainings have to be encouraged.

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