



MEDTEC SCHOOL

Course: Patient Specific Modelling and Technologies for Artificial Organs

Year (1st-2nd-3rd-4th-5th-6th): 4th

Period (1st-2nd semester – annual): 2nd semester

Credits: 6

Objectives

The course is aimed at providing the students with the proper methodologies to design and evaluate life support systems and artificial internal organs, namely artificial lung/ventilation systems, artificial kidney/dialysis therapy, artificial heart/ventricular assist devices, being them either implantable, or para-, or extra-corporeal. The machine to patient interaction will be focussed and discussed. Based on the physiology of the native internal organs, the design of life support systems will be focussed referring to the mechanical and physico-chemical phenomena taking place in them. Mass transfer, energy supply and converters, will be described with reference to the specific application. Criteria on how to optimize and adjust the performance and efficiency of the systems will be given also paying attention to the specific life-style of the patient, through the introduction of patient specific modelling procedures.

Moreover, the course aims at giving the students hints about ethical approaches to the design of life saving devices and to bring students to make autonomous judgements about the possible solutions to be adopted.

Along the course clinical applications/implantation procedure and devices will be shown to the students either in the form of videos/slides, or showing real commercial devices possibly involving companies active in the specific field.

With reference to the Dublin Descriptors listed hereunder:

DD1 - Knowledge and understanding;

DD2 - Applying knowledge and understanding;

DD3 - Making judgements;

DD4 - Communication skills;

DD5 - Learning skills

students are expected to develop and acquire abilities to meet all the Descriptors, namely applied to:



- knowledge of the main concepts about the design constraints and specifications of the artificial internal organs or life support systems focussed during the course;
- understanding of the main physical, mechanical, and chemical phenomena taking place in the devices with specific reference to patient-machine interaction;
- knowledge to quantify, and evaluate the performances of the devices;
- ability to develop, judge and apply patient specific approaches to the evaluation of artificial systems and know how to optimize the interaction with the living organism;
- development of skills to face and communicate/promote innovation in this field.

Prerequisites

Attendance of the courses Biomechanics and Thermodynamics, and Biomaterials is necessary. However, the main concepts from these courses will be recalled anytime these concepts should be essential to ease and deepen students' knowledge.

Contents

The course is aimed at teaching design criteria and evaluation criteria of artificial internal organs and life support systems devices, and how to deal with patient specific application of the taught devices.

More specifically, the main subjects are the following:

- Design criteria and optimisation of life support systems devices/artificial internal organs;
- Materials choice;
- Biological constraints;
- Adjustment methods and criteria to optimise the machine to patient interface;
- Optimization criteria for device setting;
- Mass transfer in solutions and through artificial membranes;
- Design and optimisation principles of dialysis filters and oxygenators;
- Design and optimization principles of blood pumps;
- Energy sources and converters;

- Efficiency evaluation and optimisation criteria of the systems;

International standards prescription related to the testing and the production of life support systems will also be presented.

Practical class activities will deal with the solution of problems related to the design and evaluation of the studied life support system/artificial organs.



Teaching Methods

Teaching will consist in lectures during which many practical examples will be provided. Moreover, videos, and devices will be used to improve students understanding and evaluation.

Practical sessions will be also proposed to the class, so that the students will learn how to quantify the pros and cons of devices applications.

Students are strongly encouraged to actively participate to the lectures with questions and comments.

Assessment

The final exam will consist in a written test (which in specific cases can be followed by a short oral exam).

The students will be evaluated based on their capacity to answer theoretical questions about the subjects taught during the course and to frame them in a wider scenario. More specifically skills about knowledge and understanding and communications, will be evaluated. Moreover, the student will be evaluated based on his/her capacity to establish connections among the different subjects dealt with during the course.

More specifically, students' skills in applying knowledge and understanding to problem solving, in making judgements about the possible technical choices, and in communication modalities to explain and assess the validity of the chosen methods, will be evaluated (as per DD1, DD2, DD3, DD4, DD5).

Texts

Notes and other material will be given to the students together with journal papers.