Introduction to Bioengineering

Academic Year: (2023 / 2024) **Review date: 19-12-2023**

Department assigned to the subject: Bioengineering Department

Coordinating teacher: ABELLA GARCIA, MONICA

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

It is convenient, although not a requirement, to have a good previous background on:
- Physics
- Chemistry
- Biology

SKILLS AND LEARNING OUTCOMES

RA1: Acquire knowledge and understanding of the basic general fundamentals of engineering and biomedical sciences.
CB1: Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2: Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CG1: Adequate knowledge and skills to analyse and synthesise basic problems related to engineering and biomedical sciences, solve them and communicate them efficiently.
CG3: Knowledge of basic scientific and technical subjects that enables them to learn new methods and technologies, as well as providing them with great versatility to adapt to new situations.
CG4: Ability to solve problems with initiative, decision-making, creativity, and to communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the biomedical engineer's activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG5: Adequate knowledge of the field of work of the biomedical engineer in companies, health or biomedical research centres.
CG8: Ability to solve mathematical, physical, chemical and biochemical problems that may arise in biomedical engineering.
ECRT1: Ability to solve mathematical problems that may arise in engineering and biomedicine. Ability to apply knowledge of: linear algebra; geometry; differential and integral calculus; differential and partial derivative equations; numerical methods; numerical algorithms; statistics and optimisation.
ECRT2: Ability to solve physical problems that may arise in engineering and biomedicine. Ability to apply knowledge of: kinematics; dynamics; electromagnetism; waves; small oscillations; thermodynamics.
ECRT3: Ability to solve basic chemistry problems that may arise in engineering and biomedicine. Ability to apply knowledge of: Chemical elements and bonding. Thermochemistry and chemical kinetics. Ideal gases. Chemical equilibrium. Electrochemistry. Applied organic and inorganic chemistry. Instrumental analysis.
ECRT31: Acquire knowledge of the role of bioengineering in today's world, the career opportunities of the degree, the different fields of application it addresses and the techniques available for solving problems in this area.
CT1: Ability to communicate knowledge orally and in writing to both specialised and non-specialised audiences.

OBJECTIVES

The course provides an updated perspective of the major developments in biomedical engineering, and introduces the way biology, mathematics and engineering can be applied to biomedical problems. The fundamental principles that underlie biomedical engineering design, analysis, and modeling procedures will be developed in addition to practical examples of the techniques commonly used to solve them.
Students will thus acquire an overview of most of the major fields of activity in which biomedical engineers are engaged and they will also have the opportunity to see these technologies in practice by visiting the real environment of a modern hospital (Gregorio Marañón) and an important research center (CIEMAT).

DESCRIPTION OF CONTENTS: PROGRAMME

The discipline of biomedical engineering has evolved over the past fifty years, making it clear that it includes a diverse, seemingly all-encompassing range of fields of specialization such as bioinstrumentation, bioimaging, biomechanics, biomaterials, and biomolecular engineering. The program below constitutes a selection of the most important basic tools that will be necessary for a biomedical engineer, suited to a 6 credit course.
PROGRAM:
- Introduction to Biomedical Engineering: The Role of a Biomedical Engineer
- Basics on Medical Instrumentation and Devices: Electricity and Electronics
- Medical Imaging: Digital image processing, X-Ray, Nuclear Medicine, Magnetic Resonance, Ultrasound and Medical Optics
- The foundations of modern Biomedicine: Cell and Molecular Biology, Genomics and Bioinformatics
- Regenerative Medicine and Tissue Engineering

LEARNING ACTIVITIES AND METHODOLOGY

Teaching methodology will be mainly based on the following modules:

* Introduction: Presentation of the course, the degree and the tracks and discussion of the role of the Biomedical Engineer and possible professional outcomes. Almost half of the session will be interactive, conducted by the doubts and questions from the students.

* Basic concepts: Theoretical sessions covering basic concepts that will be vital to the professional development in the different areas: Tissue Engineering, Medical Imaging and Biomedical Instrumentation.

* Practical cases: Example of current tecnology, examining the involved disciplines and identification of the application of the basic concets seen in the theoretical sessions.

* Laboratory sessions: Practical sessions where the students see the comented technologies and use different tolos that they will encounter in theri professionl life. A report guideline will be handed to be filled up during the session.

* Visits: Visits to two centers, Gregorio Marañón Hospital and CIEMAT research Center, that will allow the students to see firsthand how daily work is in these environments and what type of technologies are used. A list of questions will be handed to be filled up during the session.

Grading will be based: 60% of continuous evaluation based mainly on short exams and laboratory/visits reports and 40% of a final exam covering the whole subject. Help sessions and tutorial classes will be held prior to the final exam.

Attendance to lectures and short-exams is not compulsory. However, failure to attend any exam will result in a mark of 0 in the corresponding continuous evaluation block.

The practical sessions may consist on laboratory work or visits to research or clinical centers. A laboratory report may be required for each of them. The attendance to practical sessions is mandatory. Failure to hand in the laboratory reports or unjustified lack of attendance will result in 0 marking for that continuous evaluation block.

ASSESSMENT SYSTEM

% end-of-term-examination:	40
% of continuous assessment (assigments, laboratory, practicals…):	60

Continuous evaluation: It accounts for up to 60% of the final score of the subject, and includes three components:
1) Short-exams: These short exams will be 15-minute tests covering previous sessions that will be advertised at least one week in advance.
2) Practical sessions/visits: They will be assessed through laboratory/visit reports and/or questionnaires that will be handed in at the beginning of each session. Attendance to all practical sessions is mandatory.
3) Student participation: It includes contribution to seminars, forum in Aula global, attitude, etc.

Final exam: The final exam will cover the whole subject and will account 40% of the final score. It will consist on two parts; the minimum score for each part to pass the subject is 4.0 over 10, notwithstanding the mark obtained in the continuous evaluation.

Extraordinary exams: The mark for students attending any extraordinary examination will be the maximum between:
a) 100% exam
b) 40% exam and 60% continuous evaluation if it is available in the same course
The extraordinary examn will consist on two parts; the minimum score for each part to pass the subject is 4.0 over 10, notwithstanding the mark obtained in the continuous evaluation.

Academic conduct: All exams will be closed-book, closed-notes, no PC or mobile phone, or anything else other than a writing implement and the exam itself. Plagiarism, cheating or other acts of academic dishonesty will not be tolerated. Any infractions whatsoever will result in a failing grade.

BASIC BIBLIOGRAPHY

- J.D. Bronzino The Biomedical Engineering Handbook, CRC Press, 1995.

- J.D. Enderle, S.M. Blanchard, and J.D. Bronzino Introduction to Biomedical Engineering, Boston: Elsevier Academic Press, 2005.

- J.G. Webster Medical Instrumentation Application and Design, Ed., John Wiley Sons, Inc., 2010.

- Jerry L. Prince, Jonathan Links Medical Imaging Signals and Systems, Prentice Hall, 2014

- M. Saltzman Biomedical Engineering: Bridging Medicine and Technology, Cambridge University Press, 2009.