Biomedical Imaging Systems

Identification

Degree: Bachelor's degree in Biomedical Engineering

Course: Second Year

Term: 3rd term

ECTS credits: 5, including 44 hours of activities in the classroom and 81 hours of self-studying. The classroom activities will consist in 19 hours of lectures, 12 hours of seminars and 12 hours of practices.

Teachers

The course coordinator and theory professor is Bart Bijnens.

Practice professor: Marta Guardiola.

Seminar professors: Maria Palazzi and collaborators (CEXS): Manuel Algara, Juan Domingo Gispert, Jose Maiques, Juan Martínez, Santiago Medrano, Jaume Quera and Martí Lacruz.

Contents

Basics of energy-matter interaction. Atoms and the electromagnetic radiation spectrum. Determinants of diagnostic image quality. X-ray generation, projection radiography, fluoroscopy, computed tomography, tomographic reconstruction. MRI, magnetic resonance principle, positioning systems using gradients and excitation sequences and reading. Flow measurement and other advanced properties of magnetic resonance. Ultrasonography - operating principle and mode of operation, Doppler effect. Nuclear Medicine - radioactivity and nuclear transformations, production of radiotracers. Positron emission tomography and positron emission single photon. Introduction to techniques of microscopy.

Theory Syllabus

Lecture classes (taught in English).

1. Introduction to Medical Imaging + X-ray Imaging (3h)

2. Computed tomography and Synchrotron X-ray Imaging (3h)

3. Ultrasonic Imaging (3h)

4. Nuclear Medicine (3h)

5. Magnetic Resonance Imaging (3h)

6. Integrated Cardiac Imaging (3h)

7. Radiological Protection (1h)

Practices

Practices are held in groups of 30 students (6 sessions 2h par session). Students will work in groups of 2 and each group will receive a different task to perform.

Practical sessions will include simulation and reconstruction of ultrasound images using Matlab or Python.

1. Generate "RF sector scan lines" for a given geometry (in motion) and reconstruct the M-mode images.

2. Rebuild moving images in a sector.

3. Estimate velocities using "Pulsed and Continuous Wave Doppler."

4. Rebuild the spectrum of "Pulsed and Continuous Wave Doppler."

5. Estimate velocities using a model of "Colour Doppler."

6. Rebuild of moving images of "Color Doppler."

At the end of the practice session, students must submit a written report containing the images obtained in each session.

Seminars

The seminars are conducted in groups of 15 students (12 h).

The first part of the seminar will go into a detailed clinical imaging modality (5 sessions of 2 hours / session):

Fundamentals and applications of reconstruction from projections

1. Acquisition of projections - foundations.

2. Generation of simple projections of objects.

3. Reconstruction ("Filtered back projection / Iterative") - fundamentals.

4. Reconstruction of an object using "filtered back projection".

5. Iterative Reconstruction of an object.

At the end of the seminar sessions, you must submit a written report containing the images obtained in each session.

The second part will consist of a visit to a hospital (1h)

• Visit of clinical imaging modalities

The third part consists of a practice session on radiation protection (1h)

• Measurement of radiation

Assessment

The evaluation of academic performance will be as follows (out 10 points):

- Oral exam with written preparation (recoverable): 60%

- Written report of the exercise imaging ultrasound (non-recoverable): 20%

- Written report for the year of reconstruction image (non-recoverable): 20%

To pass the course it is necessary to achieve the following requirements:

• Obtain a grade equal to or greater than 50% in the written test.

• Obtain a grade equal to or greater than 50% in the notes.

• Attend and deliver seminars and practices.

Requirements

- Notes for each topic, as well as scripts for practices and seminars are available in the Aula Global.

- Attendance at practice classes is mandatory.

- Students are not allowed to change their group without the approval of the Secretary Office.

Bibliography

Suetens P., Fundamentals of Medical Imaging, 2nd edition, Cambridge University Press, 2009.