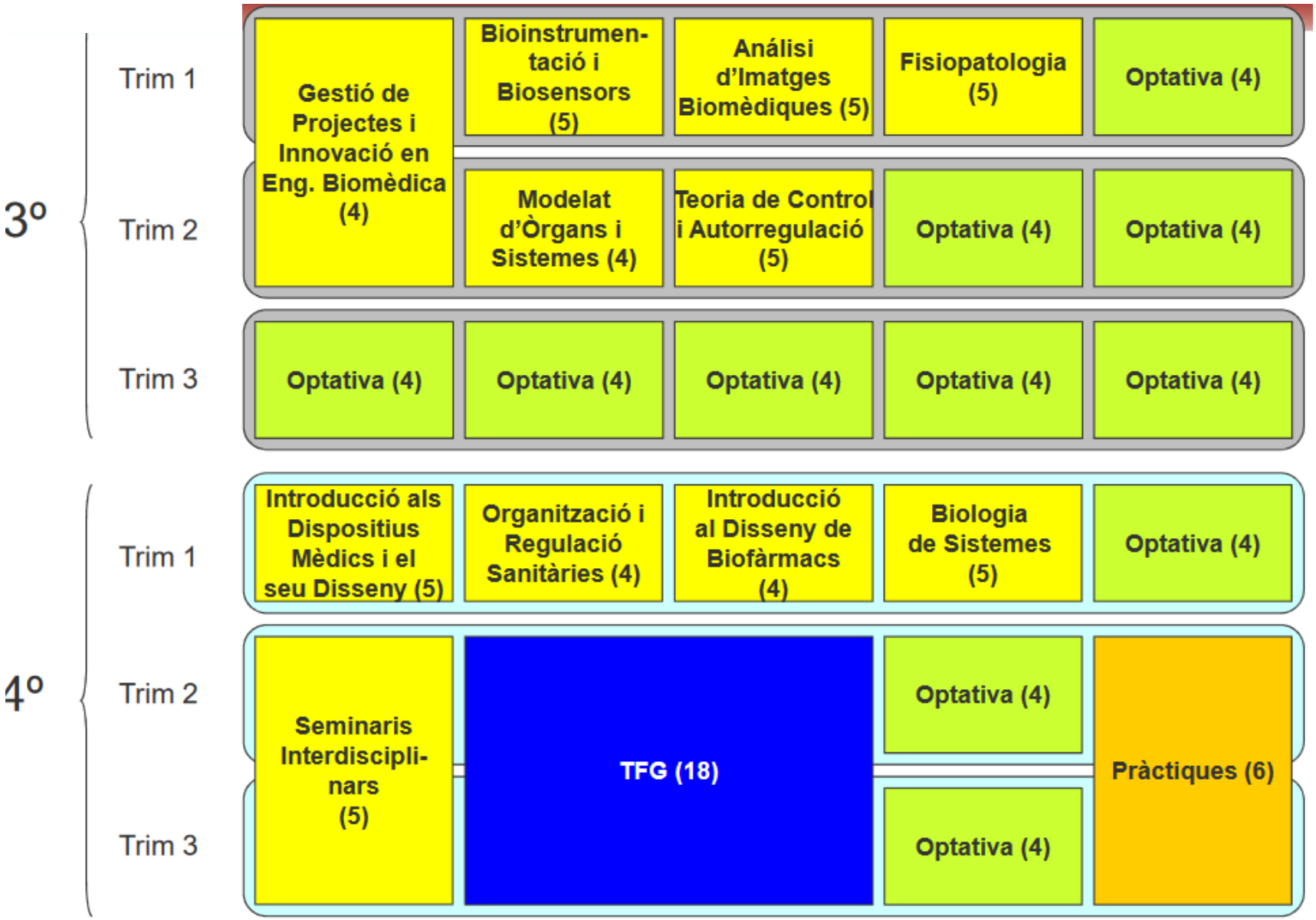
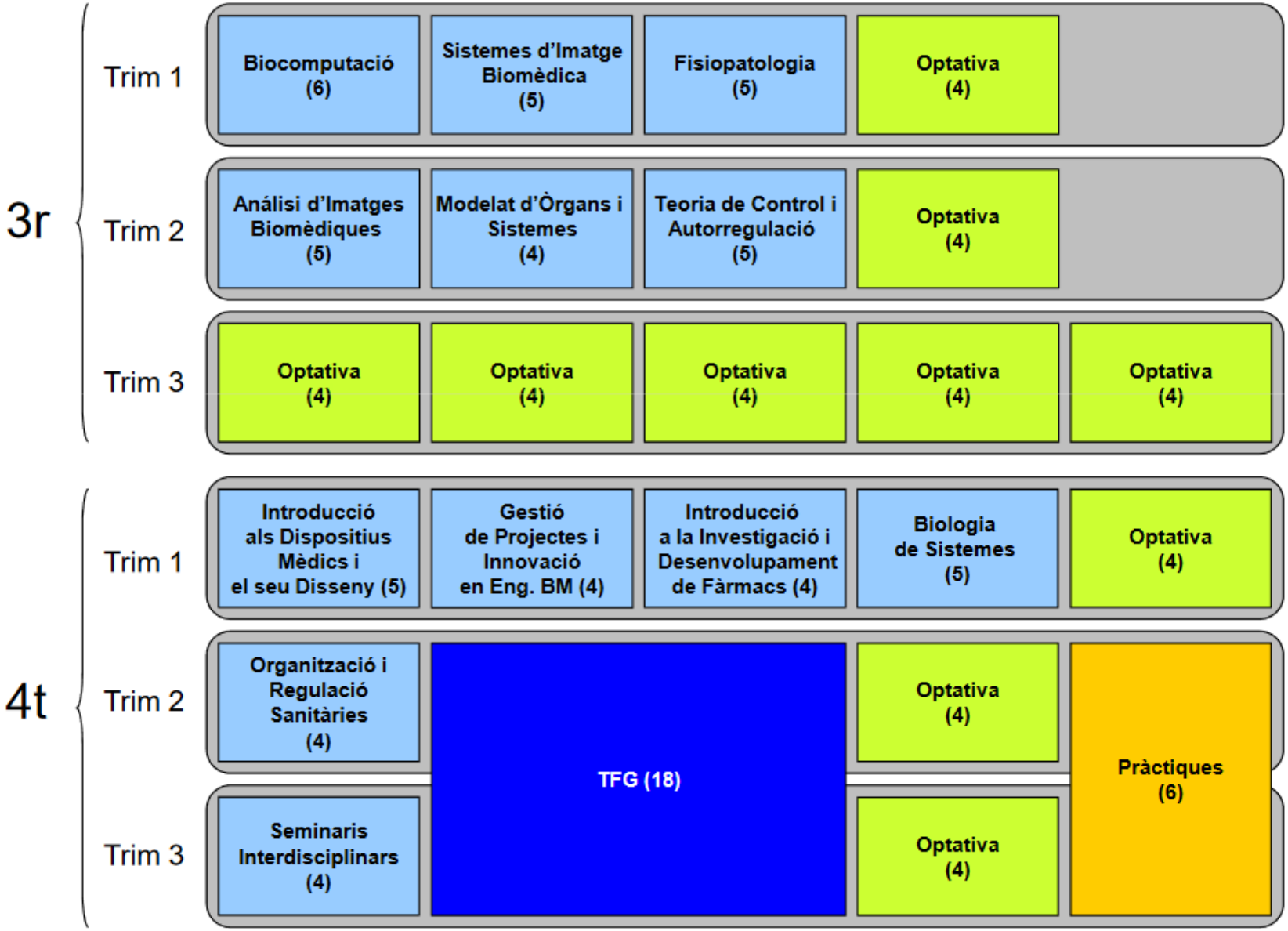
Syllabus 3rd and 4th years (2009)



Syllabus 3rd and 4th years (2016)



Elective courses BME degree

- 1st trimester
  - **Advanced synthetic biology (DCEXS)**
  - **Nanomedicine and Nanobiotechnology (DCEXS)**
- 2nd trimester
  - **Advanced analysis of neuronal signals (DTIC)**
  - **Computational cardiology (DTIC)**
  - **Face recognition (DTIC, audiovisual systems)**
- 3rd trimester
  - **Advanced analysis of biomedical (DTIC)**
  - **Planning and guidance for minimally-invasive interventions (DTIC)**
  - **Osteomuscular modelling (DTIC)**
  - **Computational neurology (DTIC/DCEXS)**
  - **Clinical medicine (DCEXS, Hospital del Mar)**
  - **Modelling of complex diseases (DCEXS)**

Elective courses BME degree

- 3rd trimester
  - **Neuroscience (DCEXS, human biology)**
  - **Virology (DCEXS, human biology)**
  - **Genomics (DCEXS, human biology)**
  - **Developmental biology (DCEXS, human biology)**
  - **Genetics (DCEXS, human biology)**
  - **Synthetic images (DTIC, computer science)**
  - **Innovation management (DTIC, telematics)**
  - **Three-dimensional vision (DTIC, audiovisual systems)**
  - **Automatic learning and data mining (DTIC, audiovisual systems)**

  - **And others: Software engineering for web apps, object-oriented programming**

NANOMEDINE AND NANOTECHNOLOGY
(1st TRIMESTER, ENGLISH)

- Coordination: Pilar Rivera (DCEXS)

- The main goal of this subject is to present how biomedicine can benefit from nanotechnology

- Topics
  - Fundamental concepts: surface, colloid, nanometer scales
  - Inorganic synthesis of nanoparticles
  - Characterization techniques: spectroscopy, Raman scattering, optical microscopy (dark field, fluorescence), electron microscopy, hyperspectral imaging, nanotoxicity, biodistribution
  - Biomedical applications: control release of drugs, bio-sensing, imaging, hyperthemia

- Labs will be devoted to several experiments: the synthesis of plasmonic nanoparticles; characterization of physicochemical properties of nanoparticles; culturing and nanoparticle exposure of cancer

ADVANCED SYNTHETIC BIOLOGY
(1st TRIMESTER, ENGLISH)

- Coordinator: Javier Macía (DCEXS)

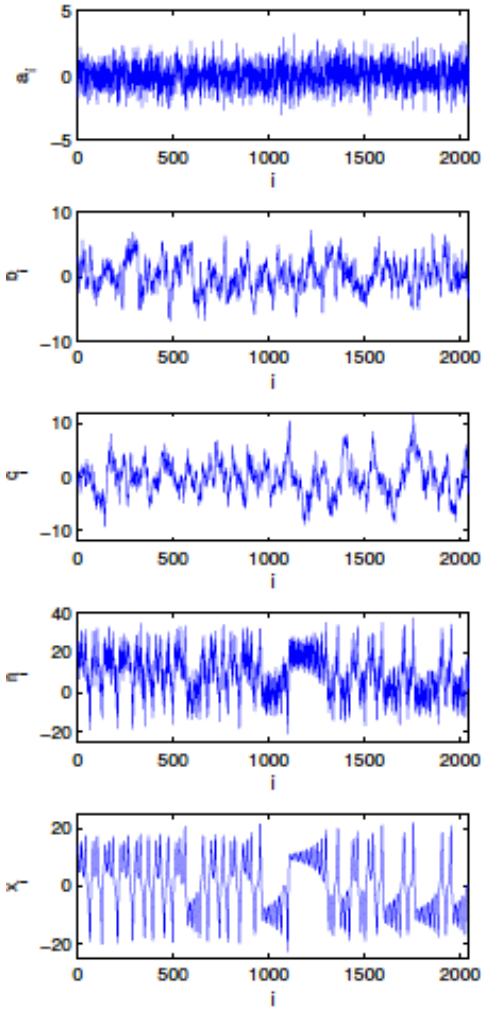
- General objectives: The teaching project addresses fundamental aspects related with biological elements, at different scales levels (molecules, genes and cells) from an engineering point of view. How to modify natural systems to create synthetic devices is at the core of this course. The students must be able to manage theoretical/computational (dry lab), and experimental (wet lab) tools in order to design and create these new synthetic devices. The main goal of the course is to teach the students in a way that they are able to understand the concepts more than memorize details. It should strengthen their critical thinking and enable them to integrate these concepts with others from different scientific disciplines.

- Topics
  - Protein engineering
  - Metabolic engineering
  - Genetic circuits in prokaryotes
  - Genetic circuits in eukaryotes

ADVANCED ANALYSIS OF NEURONAL SIGNALS
(2nd TRIMESTER, ENGLISH)

- Professors: Ralph G. Andrzejak (DTIC), Rubén Moreno (DTIC)

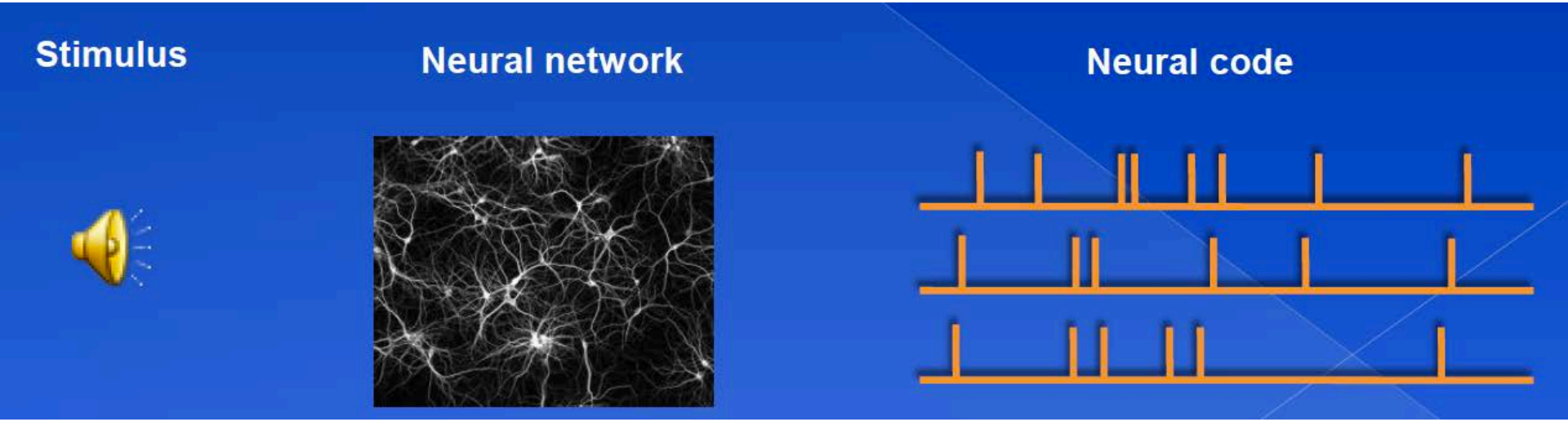
- Part 1: Nonlinear time series analysis
  - Analyze experimental signals to characterize
  - the underlying dynamics
  - Detect non-random structure in signals
  - Test null hypothesis about signals
  - Signals: model signals, electroencephalogram
  - Dynamics: model systems, brain
- Approach
  - Very strong emphasis on concrete examples to understand the theoretical concepts
  - Analyze database of electroencephalographic signals from epilepsy patients (see ntsa.upf.edu)
  - Matlab will be used in the theory, labs and seminars
  - High degree of interaction in all sessions



ADVANCED ANALYSIS OF NEURONAL SIGNALS
(2nd TRIMESTER, ENGLISH)

- Instructors: Ralph G. Andrzejak (DTIC), Rubén Moreno (DTIC)

- Part 2: Neural coding and decoding: link between neural response and stimulus
  - Spike trains and firing rates: Spike train statistics
  - The neural code
    - Rate coding
    - Temporal coding
  - Information theory
    - Entropy / Mutual information
    - Entropy and information for spike trains



COMPUTATIONAL CARDIOLOGY
(2nd TRIMESTER, ENGLISH)

- Instructors: Oscar Camara (DTIC), Bart Bijnens (DTIC), Andy Olivares (DTIC), Mariano Vázquez (BSC), Jazmin Aguado-Sierra (BSC), Juan Cajas (BSC), Eduardo Soudah (CIMNE)

- The course will cover the main aspects of multi-physics cardiac modelling, emphasizing the different steps for the generation of patient-specific and generic simulations

- Topics
  - (Reminder of) Cardiac physiology and physiology
  - Modelling of cardiac anatomy
  - Mechanical modelling
  - Cardiac electrophysiology and electromechanical modelling
  - Haemodynamics and Fluid modelling

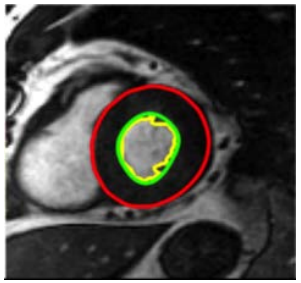
- Labs will consist on running simulations on an open-source solver

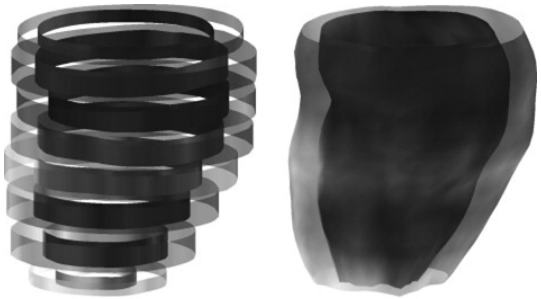
ADVANCED ANALYSIS OF BIOMEDICAL IMAGES AND SIGNALS (CARDIOVASCULAR SYSTEM): SEGMENTATION & QUANTIFICATION
(3rd TRIMESTER, ENGLISH)

- Instructor: Karim Lekadir (DTIC)

- The course focuses on techniques for robust image segmentation, as well as for advanced image quantification in the context of personalised medicine (e.g. patient diagnosis).

- Topics
  - Image segmentation: atlas-based, deformable models, deep learning
  - Image quantification: manifold embedding, radiomics, deep learning





PLANNING AND GUIDANCE FOR MINIMALLY-INVASIVE INTERVENTIONS
(3rd TRIMESTER, ENGLISH)

- Instructors: Miguel Ángel González Ballester (DTIC)

- We will study the general architecture and implementation aspects of computer-assisted surgery, from planning and simulation to intraoperative navigation and surgical robotics. We will analyse several existing systems, also from the point of view of clinical applications.

- Topics
  - Planning of pre-operative trajectories and structures
  - Registration of pre-operative and intra-operative images
  - Tracking of surgical instrumentation
  - Augmented reality
  - Biomechanical deformation models
  - Applications in neuroradiology, neurosurgery, orthopaedics, hyperthermic ablations, endoscopy, among others

- In labs sessions, students will become familiar to open-source libraries covering several topics in computer-assisted surgery

OSTEOMUSCULAR MODELLING
(3rd TRIMESTER, ENGLISH)

- Instructors: Jérôme Noailly (DTIC)

- This subject gives an overall overview of the technological needs that intervene in the use of muscle-skeletal models for the analysis and treatment of patients with osteomuscular diseases.

- Topics
  - Introduction to muscle-skeletal system and mechanobiology
  - Approaches for modelling
  - Modelling tissues of the muscle-skeletal system
  - Calibration and validation
  - Integration of clinical data and protocols (imaging, EMG, motion capture)
  - Practical use cases in orthopaedics (virtual trial and design of implants, modeling platforms of the prognosis and prediction of fractures

- Several clinicians and researchers from labs and companies on this field will present their work and experience in the seminar sessions; for labs, the students will perform a team-work project planning and designing a model of a given region of the human muscle-skeletal system

COMPUTATIONAL NEUROSCIENCE
(3rd TRIMESTER, ENGLISH)

- Instructors: Rubén Moreno (DTIC), Jordi García-Ojalvo (DCEXS)

- The overall goal of the subject is to gain fundamental insights into brain function and the neural mechanisms underlying such function. To this end, theoretical and computational tools will be presented, which largely rely on the theory of dynamical systems. The behaviour of the nervous system will be considered at different levels of complexity ranging from the neuronal level to the system level in which biophysically plausible networks of neurons will be studied.

- Topics
  - Neurons
  - Synapses
  - Mean-field approximation
  - Network level

- Hands-on practical work based on Matlab and Python to perform computational analysis of real neuronal data

MODELLING OF COMPLEX DISEASES
(3rd TRIMESTER, ENGLISH)

- Coordinator: Ricard Solé (DCEXS)

- This course will provide the students with a number of general tools to approach diseases under a network perspective, the levels of complexity that need to be considered while studying a given pathology and different ways of approaching it, from the clinics to imaging and theoretical/computational modelling. Case studies will be analysed.

- Diseases
  - Cancer (colon, glioblastoma, leukemia)
  - Brain diseases (Alzheimer's disease, schizophrenia, multiple sclerosis)
  - Immune system pathologies and immune-related diseases (AIDS, diabetes I and MS)

- Some seminars given by experts in different diseases

CLINICAL MEDICINE
(3rd TRIMESTER, CATALAN)

- Coordination: Luisa Sorlí (DCEXS)

- In this subject the student will put into practice in a real clinical environment the skills and knowledge acquired during the degree. For this, a deep understanding of the main medical pathologies and the available technology for their diagnostic and treatment in clinical routine is needed. Different medical and surgical specializations will be targeted.

- Practical sessions (60% of the subject) will consist on visits to different services at Hospital del Mar.

- Students will develop an individual project to create or improve any of the devices/technology currently used in clinical routine. Poster sessions will also be organized.

- Only 15 students (priority for 4th year students and best grades)

Elective courses - Practical information

- Particular characteristic of BME degree at UPF
  - A lot of elective courses
  - A lot of freedom
  - A lot of decisions to be made

- (Relatively) Bad side of the story
  - Not perfect schedules → impossible to fully avoid overlaps
  - Over the years → non-critical overlaps, teacher/student flexibility
  - Flexibility from Secretaria on enrolment

- Get as much information as you can from teachers (teaching plans, etc.) and former students