Sessió informativa optatives GEBM 2015-2016

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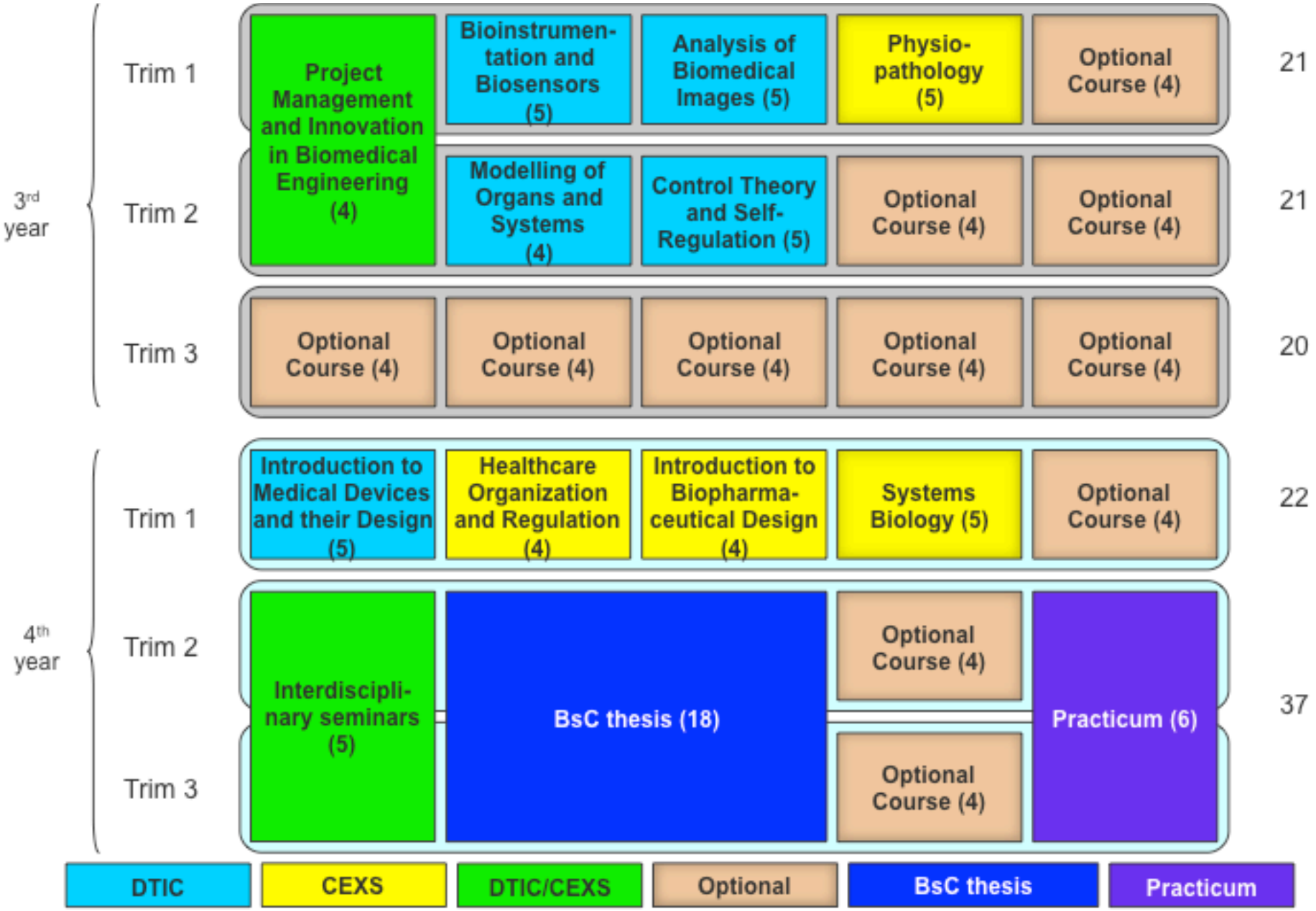
Syllabus 3rd and 4th year



ELECTIVE COURSE LIST. BIOMEDICAL ENGINEERING

- 1st trimester
  - **Advanced synthetic biology (CEXS)**
- 2nd trimester
  - **Advanced analysis of neuronal signals (DTIC)**
  - **Computational cardiology (CEXS)**
- 3rd trimester
  - **Advanced analysis of biomedical images (cardiovascular system): segmentation and quantification (DTIC)**
  - **Planning and guidance for minimally-invasive interventions (DTIC)**
  - **Computational neurology (DTIC/CEXS)**
  - **Clinical medicine (CEXS)**
  - **Modelling of complex diseases (CEXS)**

  - **Osteomuscular modelling (DTIC). Bi-annual (re-opened 2016-2017)**

ELECTIVE COURSE LIST. BIOMEDICAL ENGINEERING

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

ADVANCED SYNTHETIC BIOLOGY
(1st TRIMESTER, ENGLISH)

- Coordinator: Javier Macía

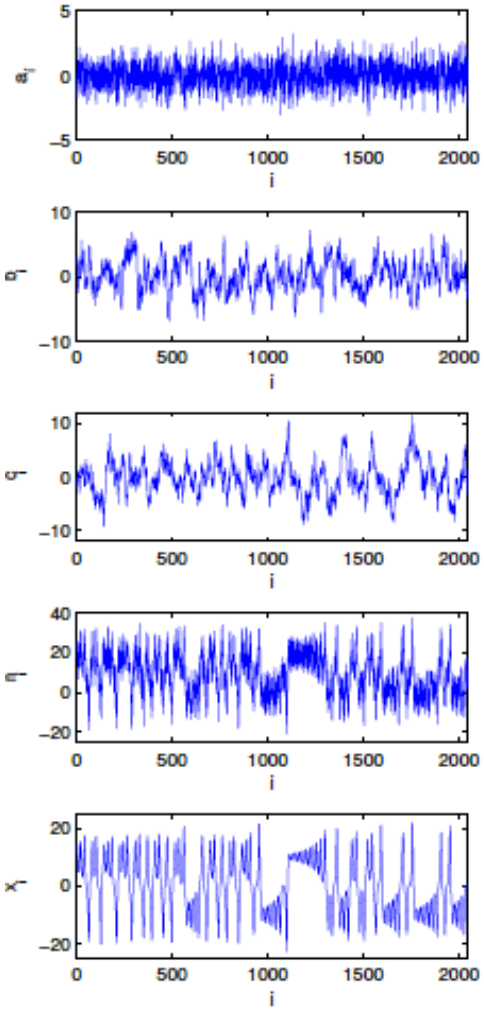
- General objectives: The teaching project addresses fundamental aspects related with biological elements, at different scales levels (molecules, genes and cells) from an engineering point of view. How to modify natural systems to create synthetic devices is at the core of this course. The students must 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 & Laura Dempere-Marco

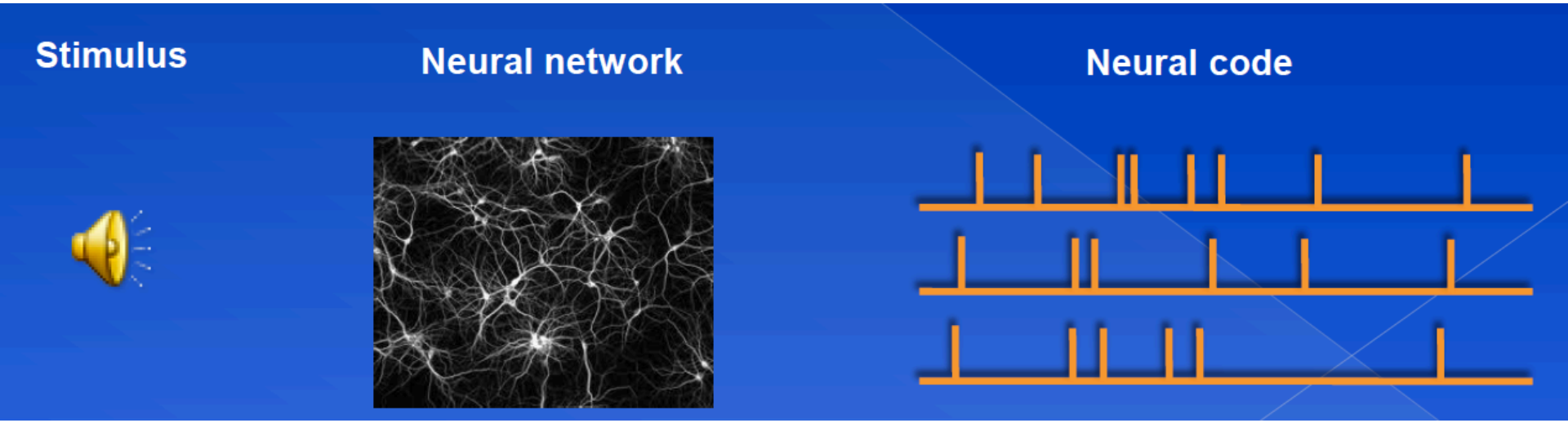
- Part 1: Nonlinear time series analysis
  - Analyze experimental signals to characterize
  - the underlying dynamics
  - Detect non-random structure in signals
  - Test null hypothesis about signals
  - Signals: model signals, electroencephalogram
  - Dynamics: model systems, brain
- Approach
  - Very 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 & Laura Dempere-Marco

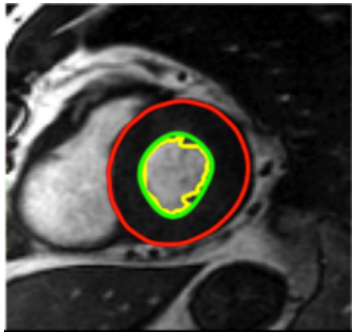
- Part 2: Neural coding and decoding: link between neural response and stimulus
  - Spike trains and firing rates: Spike train statistics
  - The neural code
    - Rate coding
    - Temporal coding
  - Information theory
    - Entropy / Mutual information
    - Entropy and information for spike trains

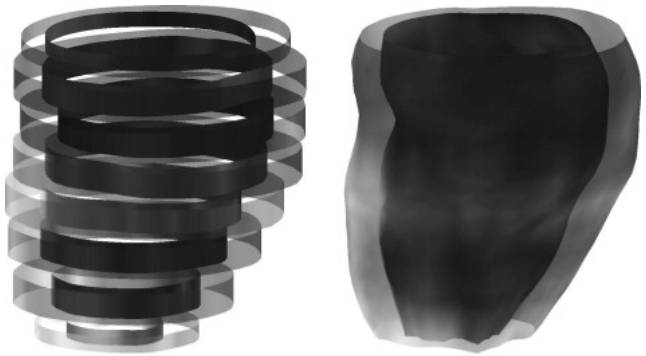


ADVANCED ANALYSIS OF BIOMEDICAL IMAGES AND SIGNALS (CARDIOVASCULAR SYSTEM): SEGMENTATION & QUANTIFICATION (3rd YEAR, 3rd TRIMESTER, ENGLISH)

- Instructor: Constantine Butakoff

- This course will be focused on the problem of segmentation applied to the cardiac function analysis.
- Topics
  - 1D: identifying the occurrence and duration of every wave in the ECG series.
  - 2D: extracting cardiac anatomy from images, representing it, and doing geometric measurements.
  - Intensity based delineation of cardiac walls like global and local image thresholding, region growing segmentation, watershed segmentation as well as statistics based method – active shape models.
  - By the end of the course we will extend some of the methods to segmentation of 3D images and 3D+time data.





COMPUTATIONAL CARDIOLOGY
(4th YEAR, 2nd TRIMESTER, ENGLISH)

- Instructors: Oscar Camara, Bart Bijnens, Mariano Vázquez (BSC), Jazmin Aguado-Sierra (BSC)

- 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
  - Patient-specific meshes
  - Substructural information
  - Electrical modelling
  - Mechanical modelling
  - Fluid modelling
- Labs will consist on running simulations on an open-source solver

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

- Instructors: Miguel Ángel González Ballester

- 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 analyze 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 librairies covering several topics in computer-assisted surgery

COMPUTATIONAL NEUROSCIENCE
(4th YEAR, 3rd TRIMESTER, ENGLISH)

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

- 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: Lucas B. Carey

- 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 (CEXS)

- 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 20 students (priorities for 4th year students and best grades)

PRACTICALITIES

- Schedules
  - Non-critical overlaps

- Flexibility
  - Depending on overlaps