**Research Projects 2018**

If you have questions about any of these projects, please contact Alberto Zanmatti Yuste at azanmatti@comillas.edu.

**CS&TELECOM PROJECTS**

**Project Title: Study and analysis of public medical corpus for research**

**Description:** It will be necessary to carry out a broad study of the structure, tools and access to a freely open medical clinical corpus developed for its use in research (MIMIC-III). This project will be focused on the analysis of this repository and its tools for extraction or retrieval of information.

**Prerequisites: P**rogramming, Databases

**Workload:** 100 hours (4 ECTS) / 200 hours (8 ECTS)

**Format:** Both are available

**Number of Students:** 1

**Project Title:** Automatic summarization from electronic medical records HER

**Description:** This project focuses on the use of tools for the generation of Automatic summarization from electronic medical records. Applying neural techniques, sequence-to-sequence models, etc. As well as, will be stidied the usefulness of tools like (ROUGE) for the evaluation of said summaries (ROUGE).

**Prerequisites: P**rogramming, Databases

**Workload:** 100 hours (4 ECTS) / 200 hours (8 ECTS)

**Format:** Both are available

**Number of Students:** 1

**Project Title:** Extraction of information from electronic medical records

**Description:** The Project focuses on the study of the Apache cTAKES ™ tool. cTAKES is a natural language processing system for extraction of information from electronic medical record clinical free-text. The main objective is the study of the capacity and usefulness of this tool for the extraction of information and its scalability of execution in the cluster environment.

**Prerequisites: P**rogramming, Databases. Experience with UMLS, Big Data recommended

**Workload:** 100 hours (4 ECTS) / 200 hours (8 ECTS)

**Format:** Both are available

**Number of Students:** 1

**Project Title:** Machine learning methods applied in diagnosis of hydropower plants

**Description:** The objective of this project is to review published methods in the area of machine learning in order to detect anomalies in the behaviour of components or systems in hydraulic power plants. This review will be used for focusing on the most effective methods found in order to be applied in some real case in Scandinavian plants.

**Prerequisites:** MATLAB at user level. Knowledge and/or interest in machine learning techniques recommended

**Workload:** 200 hours (8 ECTS)

**Format:** Semester (extensive, 15 weeks), Summer (intensive, preferably 8 weeks), Both are available

**Number of Students:** 1 or 2

**Project Title:** Assessment of Bluetooth Low Energy Networks through experimental and simulated contexts

**Description:** The aim of the project is to create a workgroup of students to asses BLE in two different context: experiments and simulations. In order to develop both studies, the workgroup will work on ns-3 simulator by defining, modeling and evaluating the performance of BLE networks in several scenarios (2 students). Also, the same scenarios will be defined using BLE dongles (USB) by programming on python over Linux (2 students).

**Prerequisites:** Any programming launguage

**Workload:** 100 hours (4 ECTS) / 200 hours (8 ECTS)

**Format:** Semester (extensive, 15 weeks), Summer (intensive, preferably 8 weeks), Both are available

**Number of Students:** 4

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**Workload:** 100 hours (4 ECTS) / 200 hours (8 ECTS)

**Format:** Semester (extensive, 15 weeks), Summer (intensive, preferably 8 weeks), Both are available

**Number of Students:** 4

**ELECTRICAL PROJECTS**

**Project Title:** Development of electric vehicles business models in US

**Description:** The deployment of plug-in electric vehicles (PEVs) has been highlighted as a transportation alternative with lower carbon emissions and as a flexible resource that can provide services to the electricity system. At the same time, battery technologies are becoming more competitive and therefore PEVs costs are decreasing. PEVs sector is developing differently around the world and the US is becoming a leader as companies such as Tesla Motors are becoming a major player in this market. The objective of this project is to describe main business models for PEVs interacting with the electricity sector in US which may include PEV aggregation, charging strategies, and development of charging infrastructure. The project will make a literature survey on ongoing initiatives and developments.

**Prerequisites:** Knowledge of electric power sector is recommended

**Workload:** 100 hours (4 ECTS)

**Format:** Semester (extensive, 15 weeks), Summer (intensive, preferably 8 weeks), Both are available

**Number of Students:** 4

**ELECTRONIC PROJECTS**

**Project Title:** RFID (Radio Frequency Identification)

**Description:** The goal of the project is to study the use of a radio frequency identification system (RFID) for factory automation. The student must study the response of the RFID systems of the laboratory with different tags (Siemens tags and ISO tags). Then, the student must integrate the RFID systems with the PLC (Programmable Logic Controller) installed in the laboratory. Finally, he must control a belt conveyor using the PLC and the RFID.

**Prerequisites:** Foundations of digital/logic system and programming.

**Workload:** 200 hours (8 ECTS)

**Format:** Semester (extensive, 15 weeks), Summer (intensive, preferably 8 weeks), Both are available

**Number of Students:** 1 or 2

**Project Title:** Robot for mounting a system

**Description:** The aim of the project is the programming of a robot for mounting a system with pieces provided by a conveyor belt system. First, the student must study the programming language of the robot ABB IRB 120 installed in the laboratory. Second, he must develop the robot programs to mount the system with pieces provided by the conveyor system (for example: LEGO pieces). Third (optionally), he can improve the system using a camera to solve the problem of random position of the pieces.

**Prerequisites:** Foundations of digital/logic system and programming.

**Workload:** 200 hours (8 ECTS)

**Format:** Semester (extensive, 15 weeks), Summer (intensive, preferably 8 weeks), Both are available

**Number of Students:** 1 or 2

**Project Title:** Inspection system

**Description:** The aim of the project is the programming of an inspection system based on a COGNEX camera for classifying pieces provided by a conveyor belt system. First, the student must study the programming language of the COGNEX camera installed in the laboratory. Second, he must develop the camera programs to inspect the pieces provided by the conveyor system (for example: LEGO pieces). Third (optionally), he can improve the system using a robot to solve the problem of pieces position.

**Prerequisites:** Foundations of digital/logic system and programming.

**Workload:** 200 hours (8 ECTS)

**Format:** Semester (extensive, 15 weeks), Summer (intensive, preferably 8 weeks), Both are available

**Number of Students:** 1 or 2

**INDUSTRIAL PROJECTS**

**Project Title:** Assessment of the European gas market

**Description:** The achievement of a competitive European gas market comprises entry-exit zones with liquid virtual trading points, where market integration is reached through appropriate levels of infrastructure, facilitating gas to move freely between market areas. At the present time, in the context of global relations and liberalized energy markets, well-working and realistic gas market models are essential in order to allocate the resources adequately and to provide the proper economic signals to suppliers, investors, consumers, etc. The goal of this project is to learn about the European gas market by reviewing the current literature on the development of gas market in Europe and to develop a model-based analysis of the current gas infrastructure across the EU.

**Prerequisites:** None

**Workload:** 100 hours (4 ECTS)

**Format:** Summer (intensive, preferably 8 weeks)

**Number of Students:** 1

**Project Title:** Analyzing the impact of short- and long-term uncertainties in long-term investment models

**Description:** In the electricity sector, there exist different types of uncertainties: short-term uncertainties that mostly affect operations, such as uncertain output of renewable energy sources; and long-term uncertainties such as the evolution of fuel prices over time, policy uncertainty, or the evolution of electricity demand. Both types of uncertainties can have an impact on optimal investment decisions, both in transmission and generation expansion. The goal of this project is to search the literature for different options to incorporate these types of uncertainties in investment decisions.

**Prerequisites:** None

**Workload:** 100 hours (4 ECTS)

**Format:** Summer (intensive, preferably 8 weeks)

**Number of Students:** 1

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**Prerequisites:** None

**Workload:** 100 hours (4 ECTS)

**Format:** Summer (intensive, preferably 8 weeks)

**Number of Students:** 1

**MATH PROJECTS**

**Project Title:** Asymptotic Behaviour of Nonlinear Dynamical System in Phase Field and Thermosyphon models

**Description:** The proposed project has as main goal the numerical study of the solutions of this kind of nonlinear dynamical models, for different values of relevant parameters. In order to solve this systems we use the Runge-Kutta method.

**Prerequisites:** Manage of MATLAB (basic level). Manage of some programming language is recommended

**Workload:** 100 hours (4 ECTS)

**Format:** Semester (extensive, 15 weeks), Summer (intensive, preferably 8 weeks), Both are available

**Number of Students:** 1 or 2

**Project Title:** Spectral Methods with Matlab. The Discrecte, Semidiscrete and Fast Fourier Transforms. Implementation with Matlab and Applications. Depending on the evolution of the project and of the number of students, other kind of numerical methods may be implemented.

**Description:** The main goal of this project is to implement with Matlab some spectral-numerical methods related with the Fourier Transform (Discrete, Semidiscrete and Fast), and to apply them to solve different problems involving diferential equations or partial differenntial equations.

**Prerequisites:** Basic knowledge of Matlab**.** Basic knowledge of numerical methods is recommended

**Workload:** 100 hours (4 ECTS)

**Format:** Summer (intensive, preferably 8 weeks)

**Number of Students:** 1 or 2

**Project Title:** Implementation of algorithms for obtaining the longitudinal profiles of roads.

**Description:** The proposed project has as main goal the implementation of algorithms to obtain the longitudinal profiles of some roads. The algorithms will be tested with adequate simulations.

**Prerequisites:** Manage of some programming language, as C, Visual Basic or Mathematica is recommended

**Workload:** 100 hours (4 ECTS)

**Format:** Summer (intensive, preferably 8 weeks)

**Number of Students:** 1 or 2

**Project Title:** Introduction course to R for data science and statistics.

**Description:** R is a free software environment for statistical computing and graphics. It compiles and runs on a wide variety of UNIX platforms, Windows and MacOS. The project consists of preparing material for an introductory course to the software R.

**Prerequisites:** Knowledge of basic statistics. Experience with other mathematical software recommended

**Workload:** 100 hours (4 ECTS)

**Format:** Summer (intensive, preferably 8 weeks)

**Number of Students:** 2

**MECHANICAL ENGINEERING PROJECTS**

**Project Title:** Optimization of mechanical and thermal properties of microencapsulated antibiotic bone cements with improved antimicrobial activity

**Description:** The aim of this project is to optimize the formulation of a bone cement loaded with antbiotic, in order to determine the optimum combination of antibiotics and microencapsulated rifampicin which provide the maximum antimicrobial activity with the optimum mechanical and thermal properties. Different mechanical tests will be performed for the mechanical characterisation of the bone cement with the differente antibiotic combinations (e.g. bending, compression and tensil tests), the thermal characterisation of the different cement formulations will be study by differencial scanning calorimetry (DSC).

**Prerequisites:** Basic skills in Materials Science Lab**.** Experience with mechanical testing recommended

**Workload:** 200 hours (8 ECTS)

**Format:** Summer (intensive, preferably 8 weeks)

**Number of Students:** 2

**Project Title:** Chemical functionalization of graphene for improved dispersión in polymeric matrix composites

**Description:** In this project, different chemical functionalisation routes of graphene (and other carbon based nanomaterials) will be developed and characterized, with the objective to optimice the dispersión of these graphene nanoparticles in the preparation of reinforced polymeric nanocomposites.

**Prerequisites:** Basic skills in Materials Science Lab**.** Experience with mechanical testing recommended

**Workload:** 200 hours (8 ECTS)

**Format:** Summer (intensive, preferably 8 weeks)

**Number of Students:** 2

**Project Title:** Improvement of the graphene dispersión procedure in the fabrication of reinforced acrylic bone cements

**Description:** In the preparation of reinforced nanomaterials, the dispersión of the nanoparticles within the matrix is probably one the key steps for an optimal mechanical improvement. In this proyecto, different dispersion techniques will be evaluated, as for example different ultrasonic methodhs, equipments and procedures or the use of diffent chemical functionalisation procedures. For the evaluation of the dispersability, the dispersion stability with the time or the effect of this dispersion over the mechanical properties of the nanocomposites, will be analyse among other parameters.

**Prerequisites:** Basic skills in Materials Science Lab**.** Experience with mechanical testing recommended

**Workload:** 200 hours (8 ECTS)

**Format:** Summer (intensive, preferably 8 weeks)

**Number of Students:** 2

**Project Title:** Improved bonding strength of acrylic adhesives reinforced with silanised graphene

**Description:** In this proyect, the reinforcement of acrylic adhesives with silanised graphene will be evaluated by the preparation of diffent speciment configurations and the performance of different characterisation tests for the determination of the joint strength, mechanical strength or fracture strength among others.

**Prerequisites:** Basic skills in Materials Science Lab**.** Experience with mechanical testing recommended

**Workload:** 200 hours (8 ECTS)

**Format:** Summer (intensive, preferably 8 weeks)

**Number of Students:** 2

**Project Title**: Development of a procedure to test bone coupons in an axial machine

**Description:** Due to its composition and structure, obtaining a general description of the material properties of bone tissue results still a challenge. A robust methodology is needed so that coupons can be extracted from bone tissue, properly characterized by imaging and biochemistry analyses and eventually subjected to deformation to measure the strain/stress field. In this project a procedure to obtain the bone coupons in a consistent repetitive way will be developed.

**Prerequisites:** Basic skills in Materials Science Lab**.** Experience with mechanical testing recommended

**Workload:** 200 hours (8 ECTS)

**Format:** Summer (intensive, preferably 8 weeks)

**Number of Students:** 2

**Project Title**: Development of a procedure to test long bones in flexion

**Description:** Structural tests on long bones requires the development of a robust method that allows positioning bones obtained from different donors (different lengths, shapes, thickness…) in a consistent way in the testing machine so that the loading environment can be compared across subjects. This is required to obtain a general characterization of the structure under study. Developing a test fixture that can accommodate for different subject-dependent geometrical changes is not straightforward. The project will develop a robust procedure to ensure maximum comparability between test samples. It will involve mechanical design of a test fixture to produce flexion in a long bone (i.e. femur).

**Prerequisites:** Basic skills in Materials Science Lab and of mechanical design**.** Experience with mechanical testing recommended

**Workload:** 200 hours (8 ECTS)

**Format:** Summer (intensive, preferably 8 weeks)

**Number of Students:** 2

**Project Title**: Evaluation of animal bone tissue mechanical properties

**Description:** Biochemical composition and structure of bone tissue change with age, this changes cause a modification of the mechanical properties. To obtain a robust description of the mechanical changes of developing tissue, three species will be considered (ovine, bovine and pig). Testing will embrace from younger specimens through full mature specimens. The expected result is a consistent description across species of how material properties change with the microstructural changes of the tissue occurring with age. In this project the mechanical properties of the animal bone tissue will be determined.

**Prerequisites:** Basic skills in Materials Science Lab**.** Experience with mechanical testing recommended

**Workload:** 200 hours (8 ECTS)

**Format:** Summer (intensive, preferably 8 weeks)

**Number of Students:** 2

**Project Title**: Mechanical characterization of teeth tissue

**Description:** Biochemical composition and structure of teeth tissue change with age and certain clinical procedures, these changes cause a modification of the mechanical properties. State of the art is too wide in this field, thus the aim of this project is the review of the mechanical properties of teeth tissue and their effect on the structural behaviour just focusing on endodontics. In addition, the antibacterial activity and strengthen capabilities of nanoparticles will be also evaluated within the endodontic environment.

**Prerequisites:** Knowledge on Material Mechanics **.** Basic skills with CAD recommended

**Workload:** 200 hours (8 ECTS)

**Format:** Spring or Summer (8 weeks minimum)

**Number of Students:** 2

**Project Title**: Cfd simulation of the irrigation in endodontics

**Description:** The treatment of diseases and injuries of the dental pulp requieres the irrigation of the root canals by means of a fine syringe. The most extended irrigant is sodium hypochlorite at low concentrations due to its antibacterial capacity. However, its high toxicity may trigger very complex clinical profiles when the clinical technics are not properly applied. Thus, the aim of this project is the computational fluid simulation of the irrigation procedure in real scanned root canals.

**Prerequisites:** Knowledge on Fluid Mechanics. Basic skills on CAD recommended

**Workload:** 200 hours (8 ECTS)

**Format:** Spring or Summer (8 weeks minimum)

**Number of Students:** 2

**Project Title**: Biomechanical study of prosthetic knees

**Description:** There are different types of prosthetic knees, mostly developed by trial and error cycles, whose suitability depends on the level of injury. Sometimes the suitability of a specific prosthetic model is not perfectly clear and its replacement may take place in just a few years. Thus, this project aims the mechanical simulation of the two most extended prosthetic knees under different loads.

**Prerequisites:** Knowledge on Material Mechanics. Basic skills with CAD.

**Workload:** 200 hours (8 ECTS)

**Format:** Spring or Summer (8 weeks minimum)

**Number of Students:** 2

**Project Title**: Improvement of microparticles separation process using additive manufacturing technologies.

**Description:** Ultrasounds can be employed for the separation of microparticles if they are focused applied to a channel through which a fluid is flowing. The size and the complexity of the channel geometry imply a great difficulty associated with its manufacturing process. In this project additive manufacturing technologies, given the fact that using a layer by layer fabrication approach involves no limitation complex geometries, will be applied to obtain different channel geometries and optimize the efficiency of the particles separation process.

**Prerequisites:** Basic skills in 3D modeling. Experience with additive manufacturing recommended

**Workload:** 200 hours (8 ECTS)

**Format:** Summer (intensive, preferably 8 weeks)/ Spring term preferred.

**Number of Students:** 2

**Project Title**: Mechanical characterization of GRP and CFRP composites reinforced with graphene nanoplatelets

**Description:** Recently, glass and carbon fibers reinforced polymer composites (GRP, CFRP) incorporating carbon nanoparticles have attracted significant interest due to their extensive applications that conventional carbon fiber reinforced composites cannot offer. This carbon nanoparticles possess unique two-dimensional structure and excellent physical and chemical properties, graphene, graphene nanoplatelets, etc, has attracted intense interest in application. In this work the influence of this nanomaterials on the mechanical behavior on GRP and CFRP will be studied.

**Prerequisites:** Basic skills in Materials Science Lab. Experience with mechanical testing recommended

**Workload:** 200 hours (8 ECTS)

**Format:** Summer (intensive, preferably 8 weeks). Spring term available

**Number of Students:** 2

**Project Title**: Behaviour of adhesive joints under elevated temperature

**Description:** Many joint structures exposed to direct sunlight or in a fire situation can reach temperatures as high as 60oºC. In this project the main objective is the characterization of the main properties of an adhesive as a function of temperature in order to model its behavior when the adhesive is exposed to heat. This will be carried out by means of mechanical tensile, DCB and TAST tests at different temperatures.

**Prerequisites:** Basic skills in Materials Science Lab. Experience with mechanical testing recommended

**Workload:** 200 hours (8 ECTS)

**Format:** Summer (intensive, preferably 8 weeks). Spring term available

**Number of Students:** 2