List of Projects Available to Incoming Cooper Union Students at ICAI

Please note, some of these projects may be taken by Spring exchange students from other universities. Also, this is a partial list, Materials Science projects will be added soon.

RESEARCH PROJECTS	
Project	Analysis of different back-end strategies of nuclear used fuel.
Abstract	Nowadays many different back-end technologies and strategies exist, in order to ensure a safety management of the nuclear used fuel. This strategies are considered an important decision for the energy future. In this project, all the strategies are going to be analyzed from an economical point of view (open cycle, closed cycle, advanced cycle, reprocessing…) In order to stablish conditions and ideas to select the better strategy.
Previous Knowledge	No previous knowledge is necessary
Supervisor	Yolanda Moratilla Soria
Dedication	Any
Workload	200 h
Number of Students	2

RESEARCH PROJECTS	
Project	Research on Visible Light Communication techniques
Abstract	Solid state lighting is predicted to replace fluorescent and other lighting sources for general illumination, due to its reliability and the potential for highly efficient sources. Compared with other sources of illumination these devices can be modulated at high data rates, offering the opportunity for communications as well as illumination from these sources. Such Visible Light Communications (VLC) has been investigated in Japan by the Visible Light Communications Consortium (VLCC). The project consist of researching about the main modulation techniques in order to transmit information using VLC and their corresponding hardware implementation. If time allows it, a simple demostration will also be built.
Previous Knowledge	electronics and communications.
Supervisor	Javier Matanza Domingo
Dedication	Semestral
Workload per student	80 h
Number of Students	2

RESEARCH PROJECTS	
Project	RFID (Radio Frequency Identification)
Abstract	The goal of this project is to study the use of a radio frequency identification system (RFID) in factory automation. After analyzing the response of the RFID systems installed in the laboratory with different types of tags (Siemens and ISO), the student will have to integrate the RFID system with a PLC (Programmable Logic Controller) to be able to automatically control the path of a pallet using a conveyor belt.
Previous Knowledge	Foundations of digital/logic systems and undergraduate-level programming.
Supervisor	José Antonio Rodríguez Mondéjar
Dedication	Any (summer intensive is preferred).
Workload per student	80 h or 160h, although the latter is desirable.
Number of Students	1 or 2. Preference: 1

RESEARCH PROJECTS	
Project	Automated mounting system
Abstract	The aim of this project is to program an industrial robot to assemble a product with pieces (e.g., LEGO bricks) provided in pallets by a conveyor belt system. The student will have to study the programming language of the ABB IRB 120 robot installed in the laboratory as a previous step to developing a program to build a given design. As the bricks could in principle be arranged differently on the pallet, the system could optionally be improved by incorporating a camera to deal with randomly positioned blocks.
Previous Knowledge	Foundations of digital/logic systems and undergraduate-level programming.
Supervisor	José Antonio Rodríguez Mondéjar
Dedication	Any (summer intensive is preferred).
Workload per student	80 h or 160h, although the latter is desirable.
Number of Students	1 or 2. Preference: 1

RESEARCH PROJECTS	
Project	Image-based inspection system
Abstract	Final product quality control is a fundamental step in any manufacturing facility. Traditionally, this work was carried out by human beings but due to the rapid development of cameras and image processing algorithms over the past few years, it is now possible to automate this process too. The aim of this project is to implement an inspection system using a COGNEX camera that is able to classify different products. After gaining some familiarity with the camera's API (Application Programming Interface), the student will have to develop an application to distinguish between several products provided by a conveyor system (e.g., LEGO brick constructions). Initially, all products will come in the same orientation; however, identification becomes harder if there is significant rotation. In case there is enough time left, the system could be improved to deal with these situations.
Previous Knowledge	Foundations of digital/logic systems and undergraduate-level programming.
Supervisor	José Antonio Rodríguez Mondéjar and Jaime Boal Martín-Larrauri
Dedication	Any (summer intensive is preferred).
Workload per student	80h or 160h, although the latter is desirable.
Number of Students	Preferably 1, the project could be adapted for up to 2 students.

RESEARCH PROJECTS	
Project	Automated warehouse
Abstract	Using ICAI's mini-factory, this project intends to reproduce a simplified version of the material distribution process of an automated factory. Based on the job orders introduced through a touch panel, an ABB IRB 120 robot will automatically pick LEGO bricks of appropriate colors and place them on a pallet. These pallets will be delivered to the assembly station using a conveyor belt. The student will be asked to program the robot, as well as the touch panel to allow introducing job orders and keeping track of the remaining stock.
Previous Knowledge	Foundations of digital/logic systems and undergraduate-level programming.
Supervisor	José Antonio Rodríguez Mondéjar and Jaime Boal Martín-Larrauri
Dedication	Any (summer intensive is preferred).
Workload per student	80h or 160h, although the latter is desirable.
Number of Students	Preferably 1, the project could be adapted for up to 2 students.

RESEARCH PROJECTS	
Project	IMPLEMENTATION OF ALGORITHMS FOR THE TREATMENT OF COMPETITION PROBLEMS IN POLITICAL ECONOMY (IV)
Abstract	The proposed project has as main goal the study of the best response for the government of a state in making- decision problems related to the political attitude and vote intention of its population. At this respect, some algorithms to solve problems of political competition when a one dimensional political space is considered (a circumference), will be developed and implemented by means of a high level program such as C or Mathematica.
Previous Knowledge	Manage of some programming language, as C, Visual Basic or Mathematica
Supervisor	Javier Rodrigo
Dedication	Summer intensive
Workload per student	100h
Number of Students	2

RESEARCH PROJECTS	
Project	IMPLEMENTATION OF ALGORITHMS FOR A PHASE-FIELD MODEL
Abstract	We consider the slow decay from metastable states of different phase-field models which stand for the dynamic phase transition between two o more differente states (thus allowing to study mixtures of two or more components). This model governs also the dynamics of the density of bacterial colony or the mass of growing tumor or even the glacier mass movement). The proposed project has as main goal to solve the phase-field equation in the one-dimensional case by numerical integration, in order to confirm the predictions of the theory results.
Previous Knowledge	Manage of some programming language, as MATLAB in order to solve the differential equations by integration scheme (as fourth order Runge-Kutta).
Supervisor	Ángela Jiménez Casas
Dedication	Summer intensive or second semester
Workload per student	100h
Number of Students	2

RESEARCH PROJECTS	
Project	IMPLEMENTATION WITH THE SOFTWARE MATLAB OF COLLOCATION METHODS AND PATH FOLLOWING TECHNIQUES, TO GET BIFURCATION DIAGRAMS FOR STEADY-STATES SOLUTIONS OF REACTION-DIFFUSION EQUATIONS
Abstract	The proposed project will be divided in two parts: • The main goal of the first part of the project will be to implement collocation methods and path following techniques with the software Matlab for a very general class of reaction-diffusion equations. • The second part of the project will be focused to get the bifurcation diagrams for steady-states solutions of a particular class of reaction-diffusion equations, of great interest from the point of view of the applications, through the files implemented in the first part of the project.
Previous Knowledge	Basic knowledge about differential equations and the software Matlab.
Supervisor	Santiago Cano Casanova
Dedication	Summer intensive or second semester
Workload per student	100h
Number of Students	1

RESEARCH PROJECTS	
Project	BASIC GUIDE OF THE TOOLBOX “SYMBOLIC MATH TOOLBOX” OF MATLAB FOR STUDENTS OF A FIRST COURSE OF A GRADE IN ENGINEERING
Abstract	The proposed project will be focused to make an elementary guide of the toolbox “Symbolic Math Toolbox” of the software Matlab, thought for students of a first course of a grade in engineering, to calculate limits, integrals, derivatives, to solve linear and nonlinear equations, to operate with matrix, to plot functions and in general, to work with mathematics.
Previous Knowledge	Knowledge of the software Matlab.
Supervisor	Santiago Cano Casanova
Dedication	Summer intensive or second semester
Workload per student	100h
Number of Students	1

RESEARCH PROJECTS	
Project	Electric vehicles and charging infrastructure in the US and in the EU
Abstract	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 the penetration levels of PEVs in the US, the development of charging infrastructure, and business models for fast charging and slow charging. In addition, the current situation in some European Union (EU) countries will be investigated. The project will make a literature survey on ongoing initiatives and developments. This work is continuation of a previous report that will be taken as starting point.
Previous Knowledge	Not required. Knowledge of electric power sector is an advantage.
Supervisor	Tomás Gómez San Román & José Pablo Chaves Ávila
Dedication	Summer intensive
Workload per student	80h or 160h
Number of Students	2 or 3

RESEARCH PROJECTS	
Project	Modelling magnetic materials in circuit simulators.
Abstract	There are several applications where non-linear magnetic materials (especially ferrites) are commonly used. Taking into account first-order characteristics of these materials (like saturation, variable differential permeability, etc.) is quite easy. It is quite more difficult to take into account more detailed behaviors; there are several approach in the technical literature and various models that try to approximate the real behavior of these materials, like for example [1]. In order characterize magnetic materials and find the parameters of the advanced models, accurate measurements are needed. Tradition approaches call for quite expensive instrumentation systems; lately a simplified method has been proposed [2] that reduce the cost and the complexity of the system at the expense of a quite more convoluted analysis of the results. These methods are quite sensible to the details of the conditioning system and on the parasitics of the devices used; these method will benefit greatly from the availability of circuital models that can be integrated into circuit simulators programs. Proprietary models for proprietary programs do exist, but they are closed source and so they are difficult to modify when the simulation is not satisfactory. [1] E. Cardelli, R. Giannetti, B. Tellini, "Numerical Characterization of Dynamic Hysteresis Loops and Losses in Soft Magnetic Materials", in IEEE Transaction on Magnetics, vol. 41(5), p. 1540--1543, May 2005 [2] B. Tellini, R. Giannetti, S. Lizón-Martínez, "Sensorless Measurement Technique for Characterization of Magnetic Materials Under Nonperiodic Conditions", in IEEE Transaction on Instrumentation and Measurement, vol. 57(7), p. 1465--1469, Jul 2008, ISSN 0018-9456.
Previous Knowledge	The student(s) is/are expected to learn how to use one of the available open source circuit simulator system [3] and to try to develop a macro-model of the magnetic materials that take into account the detailed behavior of the material. They must know basic calculus, basic electronics device and circuits, fundamentals of magnetic fields and transformer, and be at ease with computers and simulators. It helps if he or she has computer programming knowledge (any language).

	[3] http://ngspice.sourceforge.net/, http://qucs.sourceforge.net/
Supervisor	Prof. Dr. Romano Giannetti
Dedication	Better extensive, acceptable intensive.
Workload per student	80 h x 2 students
Number of Students	2

RESEARCH PROJECTS	
Project	State of the art study in nervous system signal measurement.
Abstract	The advent of MTM (Mind To Machine) direct interfaces has been advertised as “the next year technology” for the last twenty years. There are a lot of partial, disconnected results in literature that are difficult to organize, parse and evaluate critically. The objective of this work is to do an extensive state of the art bibliographic research and to write a technical resume of the recent techniques –- with hard data like type of amplifier/conditioner used, electrodes, technical characteristics of the system (noise, resolution, autonomy) and a survey of the resulting applications.
Previous Knowledge	The student must know basic calculus, electronics device and circuits, and a good understanding of amplifiers characteristics. It helps if he or she has any knowledge of biomedical electronics or engineering..
Supervisor	Prof. Dr. Romano Giannetti
Dedication	Extensive/intensive
Workload per student	80 h
Number of Students	1