TOULOUSE INP

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Master of Science Electronic systems for Embedded and Communicating Applications (ESECA)

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Syllabus

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Master 1 : Semester 7 – 30 ECTS

The semester 7 is decomposed into 6 teaching unit (TU)

SOFT SKILLS (60H) (7 ECTS)

French (FLE)

Lectures, practical sessions: 21h – ECTS : 4

Professor : Marina Barriere

Objectives : 21h hours courses provided to small students groups based on their French skills. Theses interactive joint together students from different master programs at Toulouse INP and INSA.

Communication

Professor :G.Casey

Lectures, practical sessions: 14h – ECTS : 1

Objectives : improve you skills in presenting yourself, your personal and professional experiences, the projects you are working on. Adapt your speeches to the French and European context.

Sports

Professor: Pascale Migeon

Lectures, practical sessions: 21h – ECTS : 1

Objectives : Discover sports you never thought about or improve your practice in your favourite activity. Enjoy the large facility of Toulouse INP campus for sports, and join French students for social networking around stress relief activities.

Conferences on aeronautics

Professor :A.QUOTB

Lectures, practical sessions: 4h – ECTS : 1

Objectives : Participate to conferences on aeronautics and space given by high end professionals in these domain. Take the full benefit of the proximity with Airbus, the CNES, Thales and the Research institution dedicated to aerospace in Toulouse.

MATHS (45H) (6 ECTS)

Maths Fourier Analysis

Professor : Tao Junwu

Lectures, practical sessions: 17,5h – ECTS : 2

Objectives: To apprehend the basis of Fourier analysis

Complex variables – Vector analysis

Professor: Tao Junwu

Lectures, practical sessions: 12,25h – ECTS : 2

Objectives : To apprehend the basis of complex variable and vector analysis

Probability - Statistics

Professor: Tao Junwu

Lectures, practical sessions: 15,75h – ECTS : 2

Objectives: To apprehend the basis of probability and statistics

PROGRAMMING (53H) (3 ECTS)

Basis of programming / Matlab

Professor: Marie Chabert

Lectures, practical sessions: 14h – ECTS : 1

Objectives : To apprehend the basis of Matlab

C programming

Professor: Hang Chen Seat

Lectures, practical sessions: 14h – ECTS : 1

Objectives :- To apprehend the algorithmic basic concepts and the basic concepts of the structured programming

- Study fundamental notions of C programming

Microprocessor

Professor : Adam Quotb

Lectures, practical sessions: 35h – ECTS : 1

Objectives : - Handle C programming for embedded system
- Handle microprocessor/micro-controller architecture
- Be autonomous on a project

Program: This course will be divided in three section: lessons, labs and project. During labs students will discover the architecture of PIC processor and will implement basic functions in C. During the project, student will implement an UART communication with an RFID detector. The main objective is to control a step motor. (which represent a door) by a tag RFID.

INTRODUCTION TO LABORATORY EQUIPMENT (31,5H) (1 ECTS)

Introduction to electronic laboratory equipment

Professor : Emmanuelle Peuch

Lectures, practical sessions: 17,5h – ECTS : 0

Objectives : To be able to use the electronic measurement devices Multimeter, oscilloscope, …). To generate and characterize a signal versus time and versus frequency (spectrum)

Program : basic passive circuits
basic analog integrated circuits as operational amplifiers, anaolg multiplier,…)
basic digital integrated circuits as D flip flop, binary counter,…

Introduction to RF laboratory equipment

Professor : Hamza Kaouach

Lectures, practical sessions: 14h – ECTS : 1

Objectives :- Acquire the basic notions essential to understanding the radiation of antennas and the propagation of waves.

- Have an overview of the different types of antennas encountered in current applications (IoT, SatCom, Spacial, Aeronautics …)
- Make a point-to-point link report (for different applications)
- Know how to read specifications and a datasheet for antennas
- Understand the role of digital simulation tools in the field

DIGITAL ELECTRONICS (63 H) (5 ECTS)

VHDL digital design

Professor : Adam Quotb

Lectures, practical sessions: 35h – ECTS : 3

Objectives : Programmable circuits such as FPGA are now a widely shared tool in industry as well as for research projects. Among the two languages that are in use to program these device, VHDL is the industry standard.

- Handle VHDL material description language

- Handle the architecture of an FPGA

- Be Autonomous on a project

Program : Based on practicals, the basis of the language are taught and elementary elements of digital systems (counters, registers, finite state machines) are presented.

Digital electronics project

Professor : Adam Quotb

Lectures, practical sessions: 28h – ECTS : 2

Objectives : To design a frequency meter on a Nexys4 board for a frequency range[1Hz –10 MHz]Change of unit automatically (units in Hz, kHz, MHz)and display on 4 useful digits Refreshing display every 2 seconds

Program : Use of a structural modeling:

- Only one project on Vivado
- Each component must be described by its external and internal view. It must be simulated and transferred to the FPGA to test it alone on the board,before being connected to the other components.
- The frequency meter has only one asynchronous input to initialize it.
- Use of a full synchronous design: - All inputs are synchronized
- All flip-flops are sensitive to the same clock (100 MHz in our case).

INTRODUCTION TO DIGITAL COMMUNICATIONS (77 H) (8 ECTS)

Signal processing

Professor : Marie Chabert

Lectures, practical sessions: 15,75h – ECTS : 1,5

Objectives : This course presents the different signal models: random (stationary at the second order and non-stationary), deterministic (with finite energy or with finite power). Their classical time and frequency representations, correlation functions and spectral densities, are presented and illustrated through examples. The most simple and usual signal processing, which is linear filtering, is defined and its properties and applications (identification, noise reduction) are discussed. In the last part of the course, the operations required to transform an analog signal into a digital one are presented. Ideal and real sampling with associated reconstruction formulas (Shannon formula) and quantization are presented. All the notions presented in the courses are illustrated through exercises and laboratories based upon a dedicated Matlab software.

Program : – 1 Introduction: what is signal processing? What are the applications?

2- Deterministic and random signal models

3- Correlation functions and spectral densities.

3- Linear filtering.

4- Sampling and quantization, reconstruction.

References: A. Papoulis and S. Unnikrishna Pillai, Probability, Random Variable and Stochastic Processes, McGraw Hill, Higher Education, 4th edition, 2002.

A. Oppenheim, A. Willsky, and I. Young, Signals and systems, Prentice-Hall, 1983.

H.P. Hsu, Signals and Systems, Schaums Outline, McGraw Hill, 1995.

Digital signal processing

Professor : Marie Chabert

Lectures, practical sessions: 14h – ECTS : 1,5

Objectives : This course introduces the appropriate representations and tools in the case of discrete-time signals: discrete-time convolution and the discrete-time Fourier transform. Then, non-recursive (finite impulse response) and recursive (infinite impulse response) digital filters are presented and their synthesis is detailed. Finally, the fast Fourier transform (FFT) algorithm for computation of the discrete Fourier transform, is detailed.

Program : 1- The discrete Fourier Transform

2- Spectral analysis through periodogram

3- Finite impulse response filters

4- Infinite response filters

5- Fast Fourier Transform

Reference:

Oppenheim and R. Schafer, Discrete-Time Signal Processing, Prentice-Hall Signal

Processing Series, 3rd Edition, 2014.

Digital communication

Professor : Nathalie Thomas

Lectures, practical sessions: 15,75h – ECTS : 1,5

Objectives : The objective of this course is to describe the basic physical layer solutions for digital communications

Program : Main parameters will be introduced : bit rate, bit error rate, spectral and power efficiencies. We will see how to generate a communication signal from a binary information to be transmitted (modulation process) and how to recover the binary information from the signal disturbed by the communication channel

(demodulation process). Classical baseband and carrier modulated transmissions will be considered : M-PAM (M-ary Pulse Amplitude Modulation), M-ASK (M-ary Amplitude Shift Keying), M-PSK (M-ary Phase Shift Keying), M-QAM (M-ary Quadrature Amplitude Modulation). Optimization of the modulation/demodulation process will be introduced for an AWGN (Additive White Gaussian Noise) channel with Nyquist criterion and matched filtering. Spectral and power efficiencies will be evaluated for the different possible modulator/demodultor schemes.

Bibliography: John G. Proakis, « Digital communications », Mc Graw-Hill international Edition, William C. Lindsey, Marvin K. Simon, « Telecommunication systems engineering », Prentice Hall.

Channel coding

Professor : Marie Laure Boucheret

Lectures, practical sessions: 15,75h – ECTS : 1,5

Objectives :

Program :

Simulation of communication chain

Professor : Nathalie Thomas

Lectures, practical sessions: 15,75h – ECTS : 1,5

Objectives : The objective of this course is to implement and analyze several digital communication chains.

Program : Baseband transmission chains are first implemented and studied in order to analyze their spectral efficiency, the interference problem and the influence of the Nyquist criterion, the impact of the noise and the inuence of matched filtering. Then classical carrier transmissions (4-ASK, QPSK, 8-PSK, 16-QAM) are implemented, using their equivalent lowpass channel, and compared in terms of spectral and power efficiencies. All the simulations are done using Matlab. Finally some error correcting code will be added to the QPSK based channel, in order to simulate the DVB-S physical layer (Video broadcasting via a satellite transmission).

Bibliography: John G. Proakis, « Digital communications », Mc Graw-Hill international Edition, William C. Lindsey, Marvin K. Simon, « Telecommunication systems engineering », Prentice Hall

TOULOUSE INP

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Master of Science Electronic systems for Embedded and Communicating Applications (ESECA)

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Syllabus

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Master 1 : Semester 8 – 30 ECTS

The semester 8 is decomposed into 5 teaching unit (TU)

SOFT SKILLS (133,75H) (5 ECTS)

French (FLE)

Lectures, practical sessions: 21h – ECTS : 2

Professor : Marina Barriere

Objectives : 21 hours courses provided to small students groups based on their French skills. Theses interactive joint together students from different master programs at Toulouse INP and INSA.

English

Lectures, practical sessions: 17,5h – ECTS : 2

Professor : G.Casey

Objectives : 17,5 hours courses provided to small students groups based on their English skills. Theses interactive joint together students from different master and engineering programs at Toulouse INP-N7.

Sports

Professor: Pascale Migeon

Lectures, practical sessions: 21h – ECTS : 1

Objectives : Discover sports you never thought about or improve your practice in your favourite activity. Enjoy the large facility of Toulouse INP campus for sports, and join French students for social networking around stress relief activities.

Conferences on aeronautics

Professor :A.QUOTB

Lectures, practical sessions: 4h – ECTS : 1

Objectives : Participate to conferences on aeronautics and space given by high end professionals in these domain. Take the full benefit of the proximity with Airbus, the CNES, Thales and the Research institution dedicated to aerospace in Toulouse.

Junior research project

Professor :A.QUOTB

Lectures, practical sessions: 70h – ECTS : 1

Objectives : Participate to conferences on aeronautics and space given by high end professionals in these domain. Take the full benefit of the proximity with Airbus, the CNES, Thales and the Research institution dedicated to aerospace in Toulouse.

DIGITAL ELECTRONICS (50,75H) (6 ECTS)

Digital electronics project

Professor : Julien Perchoux

Lectures, practical sessions: 26,25h – ECTS : 3

Objectives : Manage a whole VHDL/FPGA project on Nexys4.

Program : An introduction illustrates the stability issue in a digital system and expose the various techniques that ensure stability when designing with VHDL.

Front end acquisition

Professor : Julien Perchoux

Lectures, practical sessions: 24,5h – ECTS : 3

Objectives : The goal of this project is to design a front-end acquisition and an associated digital signal processing.The signal is generated by an optical sensor that produces “sawtooth-like” fringes (periodic signal with slowly increasing ramp followed by a sharp edge).By the end of the project your system shall be capable to transform sawtooth like signals into a square periodic signal of same frequency Initiation to VHDL. Knowledge and use of FPGA development flow.

OPTICS/TELECOM (56H) (4 ECTS)

Optoelectronics

Professor : Julien Perchoux

Lectures, practical sessions: 21h – ECTS : 2

Objectives : Understanding the behavior of III-V laser diodes and photonics devices in order to design optical links.

Program : Study of various laser/photodetector structures. Development of small signal models, with noise analysis. Design of high-speed digital optical links. introduction illustrates the stability issue in a digital system and expose the various techniques that ensure stability when designing with VHDL.

Laser and optical fiber sensing techniques

Professor : Thierry BOSCH, Han Cheng SEAT

Lectures, practical sessions: 17,5h – ECTS : 1

Objectives : this lecture is an overview of laser sensing techniques for metrology.

Program : Free-space laser and optical fiber remote sensing techniques are introduced for measuring physical parameters (distance, displacement, velocity). Correlated measurement of parameters such like strain / stress and vibrations in mechatronics or flow in micro-fluidics will also be presented. The domain of applications is wide from inspection of industrial processes and products (mechanics, chemical engineering...), aerospace and terrestrial transportation (non destructive testing, safety), and quality of life (biomedical, sustainable development, geoscience...).

Practical Hyper/opto

Professor : Han Cheng SEAT

Lectures, practical sessions: 17,5h – ECTS : 1

Objectives : optical links calculation, optical components selection, signals distribution.

Program : Design of an optical link between:

- an embedded optical link for the local oscillator (LO) distribution (LO frequency: 10 GHZ, SNR: 30, range: 100 m).

- a short range digital link for Ethernet applications (range : 10km, Bandwidth : 100MB/s, BER=10-11)

- a remote command system (range: 12 m, SNR: 10, directivity: 120°, bandwidth 40 kHz).

RF (77H) (7 ECTS)

Antennas

Professor : Nathalie Raveu

Lectures, practical sessions: 14h – ECTS : 1,5

Objectives : Antenna function, Systems with antennas

Program : Signal propagation principles, the antenna's fundamental parameters, types of antenna, Friis'stransmission equation, antenna arrays, how are antennas qualified?

Passive RF

Professor : Gaetan Prigent

Lectures, practical sessions: 14h – ECTS : 1

Objectives :RF spectrum and applications, Filters, Multipoles

Program : RF spectrumand applications

►Filters =>Stub-based filters, stepped impedance, Inverter-based filters, Coupled lines filters

►Multipoles => Dividers, Couplers, Hybrid couplers, Coupled-lines couplers, Couplers and applications

Active RF circuits

Professor : Gaetan Prigent

Lectures, practical sessions: 14h – ECTS : 1

Objectives : RF amplifiers and design, LNA,

Program : Technological process

►RF amplifiers => HEMT : I-V characteristics, Linearity, P1dB, IP3, efficiency,

PAE, Class of amplification, Stability of the transistors

►Amplifier design => Power matching, Gain Optimization, Wideband Amplifierp
►Design Example

►Fixed Gain amplifier

►LowNoise Amplifier (LNA)

MEMS

Professor : Gaetan Prigent

Lectures, practical sessions: 17,5h – ECTS : 2

Objectives : Understand MEMS model and application.

Program : Main applications of MEMS,

► Technological process for MEMS

►Mechanical (Static, dynamic) and RF models for MEMS

Microwave system project

Professor : Gaetan Prigent

Lectures, practical sessions: 17,5h – ECTS : 1,5

Objectives : Design of a Rx Down Converter

Program : Define the Down-converter architecture (System analysis), Define the specifications of each equipment (Budget analysis), Design each equipment, Global simulation of the system - Establish a matrix of conformity for equipments and system

ANALOG ELECTRONICS (112,5H) (8 ECTS)

Circuit 1

Professor : Anne laure Franc

Lectures, practical sessions: 12,25h – ECTS : 1

Objectives : Be able to design a stable closed-loop circuit by optimising its gain-bandwidth product.

Circuit 2

Professor : Gaetan Prigent

Lectures, practical sessions: 12,25h – ECTS : 1

Objectives : Thierry Bosch

Program : Be able to design a stable closed-loop circuit by optimising its gain-bandwidth product

Project Analog Electronics

Professor : Emmanuelle Peuch

Lectures, practical sessions: 28h – ECTS : 2

Objectives : At the end of Analog electronics project, the student will be able to: Describe the basic functions of a heterodyne receiver and characterize these functions. Describe the basic functions of a tranceiver and characterize these functions

Program : These courses are an introduction to the basics of analog and digital data transmission:

- AM, FM modulation, I/Q signals

- Features of a heterodyne receiver

- Features of a transmitter

- Introduction to SDR (Software Defined Radio) and the IoT (Internet of Things)

Analog Electronics Practical

Professor : Emmanuelle Peuch

Lectures, practical sessions: 14,5h – ECTS : 1

Objectives : At the end of these electronics labworks, the student will be able to:

- Characterize a passive circuit by its transient response and its frequency response (first and second order circuits).

- Design and implement a filter

- Implement and characterize linear and non linear circuits with operational amplifier components (amplifiers, active filters, comparators, astable circuits, ...). Identify the technical limits of these components in order to learn how to choose them for a

specific application

Program : Electronic measurement devices (oscilloscope, spectrum analyser,…) Simulation software (Pspice)

Semi conductor devices

Professor : Anne Laure Franc

Lectures, practical sessions: 12,25h – ECTS : 1

Analog filter

Professor : Gaetan Prigent

Lectures, practical sessions: 14h – ECTS : 1

Objectives : The aim of this course is to learn the design methods and synthesis techniques for analog filters.

Program : This course falls into seven parts :

- Analog front-end architecture : Heterodyne and super heterodyne architectures. Role and specifications of the filter in the system.

- Determination of a partially known stable filter function : How can we find single or a family of stable function of with knowledge of part of the electrical response (either magnitude or phase, real or imaginary parts, even or odd parts).

- Synthesis techniques to determine LC networks : Cauer, Foster and Darlington methods.

- Approximation functions : Butterworth, Tchebychev.

- Lowpass filter prototype : design method.

- Frequency transformations : bandpass-, highpass-, stopband-to-lowpass prototype transformations. LC networks transformations.

- Active filters

Transmission lines

Professor : Nathalie Raveu

Lectures, practical sessions: 19,25h – ECTS : 1

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Master of Science Electronic systems for Embedded and Communicating Applications (ESECA)

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Syllabus

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Master 2 : Semester 9 – 30 ECTS

The semester 9 is decomposed into 5 teaching unit (TU)

SOFT SKILLS (45,5) (3 ECTS)

French (FLE)

Lectures, practical sessions: 17,5h – ECTS : 1

Professor : Marina Barriere

Objectives : 17,5 hours courses provided to small students groups based on their French skills. Theses interactive joint together students from different master programs at Toulouse INP and INSA.

English

Lectures, practical sessions: 17,5h – ECTS : 1

Professor : G.Casey

Objectives : 17,5 hours courses provided to small students groups based on their English skills. Theses interactive joint together students

from different master and engineering programs at Toulouse INP-N7.

Professional communication

Professor :G.Casey

Lectures, practical sessions: 10,5h – ECTS : 1

Objectives : improve you skills in presenting yourself, your personal and professional experiences, the projects you are working on. Adapt your speeches to the French and European context.

EMBEDDED SYSTEMS (190H) (9 ECTS)

System On Chip (SOC)

Lectures, practical sessions: 57,75h – ECTS : 2

Professor : Blaise Mulliez

Objectives : 57,75 hours courses provided to small students groups. This course will provide an understanding of the concepts, issues, and process of designing highly integrated SoCs following systematic hardware/software co-design & co-verification principles with Xilinx tools.

Architectures, interfacing and reliability ES

Lectures, practical sessions: 12h – ECTS : 1

Professor : Christophe Escriba (INSA)

Mobile Autonomous platform

Lectures, practical sessions: 43,75h – ECTS : 1

Professor : Christophe Escriba (INSA)

Synthesis Strategy

Lectures, practical sessions: 31,5h – ECTS : 2

Professor : Blaise Mulliez

Objectives : Description of the FPGA flow synthesis.

VHDL design

Lectures, practical sessions: 45,5h – ECTS : 0

Professor : Blaise Mulliez

Objectives : VHDL back up standard.

POWER MANAGEMENT (52,5) (4 ECTS)

Microprocessor power supply

Lectures, practical sessions: 19,25h – ECTS : 0,8

Professor : Marc Cousineau

Objectives : Nowadays, designers in Power Management applications continually improve existing architectures and control systems of low-power DC/DC converter for numerous products: cell-phones, laptops, and others embedded electronic devices... The purpose of this tutorial is to design a DC-DC buck converter, to implement a voltage regulation loop and to study its stability.

Mosfet Driver Circuits

Lectures, practical sessions: 14h – ECTS : 0,8

Professor : Marc Cousineau

Objectives : Introduction to the driver circuit purposes Control of the voltage level and Switching-time control.

EMC for SMPS

Lectures, practical sessions: 8,75h – ECTS : 0,8

Professor : Adam Quotb

Objectives :

EMC of integrated circuit

Lectures, practical sessions: 5h – ECTS : 0,8

Professor : Adam Quotb

Objectives :

FEM modelling of integrated passive filters

Lectures, practical sessions: 5,5h – ECTS : 0,8

Professor : Adam Quotb

Objectives :

RADAR & REMOTE (22,75) (3 ECTS)

Remote sensing project

Lectures, practical sessions: 12,25h – ECTS : 2

Professor : Nathalie Raveu

Objectives : The first part of the project is dedicated to the use of CAPITOLE-RC. In the second part of the project, the students will design a RF movement sensor. The sensor should be the simplest possible at an operating frequency of 2.45GHz. In the last part of the project, the students will propose an architecture, tested on ADS with ideal components, to measure also the distance of the target from the sensor for the same operating frequence.

Radar equipment

Lectures, practical sessions: 10,5h – ECTS : 2

Professor : Nathalie Raveu

Objectives : To know the architectures of radar equipment To know which radar to choose for a given application. To know how to

define the radar architecture based on this application. To know how to test the proper functioning of the radar.

RF/OPTO (51,25) (5 ECTS)

Photonics for HF

Lectures, practical sessions: 12,25h – ECTS : 2

Professor : Julien Perchoux

Objectives : Student will discover optoelectronic components and circuits for high-speed applications.

Embedded optical systems

Lectures, practical sessions: 14,5h – ECTS : 1

Professor : Han Cheng SEAT

Objectives : Student will make Simulation and experimental characterization of an extrinsic fiber Fabry-Perot interferometer for displacement measurements. They will also Design of an intensity-based fiber optic proximity or displacement sensor. They will characterize optical fiber links for (high bit-rate) information transmission: estimating bandwidth of optical fibers and system limits. The focus in this project will be on the experimental characterization of the bandwidth of the optical fiber,the primary component in fiber optic communications systems, which provides users with bandwidths in excess of Gb/s rates. In 1996, researchers at Fujitsu, NTT Labs and Bell Labs concurrently demonstrated a capacity of 1 trillion bits/s of data transmitted through single-mode optical fibers. Nevertheless, other fiber- related components and accessories such as connectors or mating sleeves, couplers, switches, wavelength division multiplexers and splices also have an impact on the successful operation of fiber links and networks.

MMIC

Lectures, practical sessions: 24,5h – ECTS : 1

Professor : Gaetan Prigent

Objectives : Discover several aspects from semiconductor to transistors and from transistors to MMIC. To know more about MMIC, transistors and passive elements modeling. Students will discover DK OMMIC software with a MMIC conception project.

INTRDUCTION TO SCIENTIFIC RESEARCH (56,75) (6 ECTS)

Internship presentation

Lectures, practical sessions: 8,75h – ECTS : 2

Professor : Adam Quotb

Objectives : 10 minute oral presentation of M1 internship

Research project

Lectures, practical sessions: 48h – ECTS : 4

Professor : Adam Quotb

Objectives : Student will work every Thursday afternoon with a researcher on a dedicated research subject during 6 months. At the end the student will produce a 4 page article and a 10 min oral presentation

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Syllabus

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Master 2 : Semester 10 – 30 ECTS

The semester 10 is decomposed into 1 teaching unit (TU)

INTERNSHIP (6 MONTHS) (30 ECTS)

Internship

Professor : Adam Quotb

Objectives : 6 monts internship