ESIGELEC
SCHOOL OF ENGINEERING
SMART AND CONNECTED SYSTEMS

BIENVENUE EN FRANCE

EXCHANGE PROGRAM

COURSE OUTLINE
Semester 2 (February - June)

ELECTRONIC EMBEDDED SYSTEMS (ENGLISH-TAUGHT)

ACADEMIC YEAR - 2023-2024

TABLE OF CONTENTS

A. Snapshot - Courses, Modules, Duration, Weight & ECTS Credits..... 6

B. Courses Curriculum & Syllabus..... 7

THE EXCHANGE PROGRAM

A student exchange program is one that you will undertake during the course of study that you are already pursuing. This study period in another university abroad will allow you to leverage and enhance your skills in an international environment.

Course delivery will almost definitely differ from what you are used to in your university, it is therefore important that you take a close look at this course outline, in order that you understand what to expect during the semester / year at ESIGELEC. We encourage you to pay attention to the information provided to you on each module and to go through all the other points this document covers, like attendance, evaluation, support services, etc.

This document is key to making your experience at ESIGELEC a successful one.

A SEMESTER 2 (FEBRUARY -JUNE)

SNAPSHOT – COURSES, MODULES, DURATION, WEIGHT & ECTS CREDITS

Courses	Modules	Duration (hours)	Weight	ECTS Credits
30 Credits / 392 hours				
Digital Systems	Microprocessors	60	4	8
	VHDL & Logic Synthesis	30	2	
	Communication Busses	30	2	
Embedded Operating Systems	Real Time Operating Systems	30	3	6
	Embedded Linux	30	3	
Embedded Software	Embedded C programming	30	2	6
	Analysis & Design with UML	32	2	
	Embedded Java	30	2	
Instrumentation	Smart Sensors	30	3	6
	Specific Instrumentation	30	3	
Communication & Language 2	French as a Foreign Language OR English as a Foreign Language	60	4	4
Total Credits				**30**

All modules are delivered face-to-face, on campus, with all required safety measures. However, modules may be delivered partially or totally online and/or through distance mode.

B COURSE CURRICULUM & SYLLABUS

Microprocessors

Module Code: MSTSEE21 **Duration: 60h**

Objectives

At the end of this module, students will be able to:

- Understand the architecture of microprocessors
- Program microprocessors
- Study the evolution of their architecture

List of topics

- Microprocessor architecture (ALU, control unit, registers, buses)
- Data and processors (address decoding, synchronization)
- Vital signals of processors (clocks, power supply, reset)
- Microprocessor programming (languages, registers, addresses, instructions)
- Execution time, routines, passing parameters
- Principles and how exceptions/interruptions work
- Inputs/outputs
- Case study (MSP430)

VHDL & Logic Synthesis

Module Code: MSTSEE22 **Duration: 30h**

Objectives

At the end of this module, students will be able to:

- Program logic devices (PLD)
- Develop programs using VHDL language

List of topics

- Review of combinatory and sequential logic
- The different families of programmable logic devices
- Practice with synthesis tools (Xilinx or Altera targets, Quartus or ISE tools, Modelsim)

Communication Busses

Module Code: MSTSEE23 **Duration: 30h**

Objectives

At the end of this module, students will be able to:

- Use the most widely used communication busses in the field of embedded processors
- Understand technical specifications

List of topics

- RS-485
- I2C BUS, SPI BUS
- CAN BUS
- ARINC bus

Real Time Operating Systems

Module Code: MSTSEE24 **Duration: 30h**

Objectives

At the end of this module, the students will be able to:

- Understand why real-time executive is used in embedded systems
- Describe the four major categories of services provided by an executive
- Describe the necessary required materials to implement an executive in real-time
- Learn the various commercial aspects of executive suppliers
- Describe the role of scheduling, how it works and the major variations
- Calculate task times for simple situations
- List attribution rules for task priority
- Describe how the principle elements for synchronization are presented in executives
- Describe the characteristics and how an email inbox works
- Design and develop a simple multitasking application with MicroC / OSI

List of topics

- Fundamentals of multitasking and real-time
- A scheduler: its role and how it works
- Why real-time executives are used in embedded systems
- Necessary materials
- Categories of executives and their markets
- A real-time kernel: MicroC/OSII (Micro-Controller Operating Systems Version 2)
- Memory management
- Intertask communication and synchronization tools
- Using MicroC/OSII and microcontrollers

Embedded Linux

Module Code: MSTSEE25 **Duration: 30h**

Objectives

At the end of the module, the students will be able to:

- Understand the possibilities and uses of the Linux kernel for an embedded IT project.
- Learn the principle software tools used in the Linux/Unix world and how to use them to develop.
- Write a device driver for specific Linux run material
- Combine tools to create advanced functions with a minimum of programming

List of topics

- Introduction to Linux.
- How an OS fits in an embedded system.
- History of Linux and Unix systems.
- Linux compared to other embedded operating systems.
- Fundamental tools: command lines, shell scripts.
- Linux development tools.
- C programming with embedded systems.
- Linux drivers.
- Web connections and Remote Administration Tools (RATs).t

Embedded C Programming

Module Code: MSTSEE26 **Duration: 30h**

Objectives

At the end of this module, students will:

- Be familiar with the C coding practices for embedded systems
- Be familiar with the elements and tools for embedded software validation
- Develop, write and test a C language program (as per design specifications) to be used with a microprocessor with respect of good practices like MISRA-C rules
- Analyse and enumerate the various phases of development for a software project: the V cycle

List of topics

- Specificities of C Language for embedded systems (variables, memory organization, physical address access, etc.)
- Programming methods
- Software analysis and validation tools and principles for embedded systems

Analysis & Design with UML

Module Code: MSTISI2A **Duration: 32h**

Objectives

At the end of this module students will be able to:

- Be familiar with the process for designing software applications, with a special focus on the Unified Modelling Language (UML) and Java as design tools
- Be familiar with the major steps in software design, including the development of user requirements, specifications, data bases, user interfaces, and software models

List of topics

- Overview of software design: challenges, accomplishments, and failures
- Overview of software lifecycle model and its variants
- Overview of object oriented design – Java classes, objects, inheritance, associations
- Requirements analysis and use case design – UML use case and sequence diagrams
- Class design – UML class diagrams
- Modeling activities and interactions – UML activity and state diagrams

Embedded Java

Module Code: MSTSEE27 **Duration: 30h**

Objectives

At the end of this module, students will:

- Be familiar with a computer language which can be used to develop graphic applications under Windows for personal embedded systems like Pocket PCs

List of topics

- Java ME environment: interface and syntax
- Basics of programming in the Java ME environment

Smart Sensors

Module Code: MSTSEE32 **Duration: 30h**

Objectives

At the end of this module, students will:

- Be familiar with the principles and the advantages of smart sensors through different applications

List of topics

- Sensors and interfacing circuits
- Applications of smart sensors
- Architecture and components of smart sensors
- Practice with smart sensors

Specific Instrumentation

Module Code: MSTSEE29 **Duration: 30h**

Objectives

At the end of this module, students will be able to:

- Manage the entire information sampling chain in an instrumentation-type embedded system

List of topics

- The measurement chain: physical signal to digital processing
- Sensors: types, technology
- Signal conditioning: transport, filtering, amplification
- Sampling: period, response time
- Information security: accuracy, lifetime, redundancy

MtoM Communication

Module Code: MSTSEE31 **Duration: 30h**

Objectives

At the end of this module, students will:

- Be familiar with the principles of communication between machines, needing no human action

List of topics

- Sensors and servers
- Cellular networks
- Applications
- Protocols of MtoM communication

Python Programming & Image Treatments

Module Code: MSTSEE36 **Duration: 30h**

Objectives

The Python language is today, one of the most useful programming tool for engineers and is used in several applicative areas including embedded systems. The objective of this elective is to understand the environment, the tools and the scope of this language.

List of topics

- Python Development Environment
  - Python distribution and their installation
  - Python as a script language
  - Python as a programming language
  - Interactive Python (Jupiter-notebook)
  - Comparison with other programming languages
  - Installing important libraries (PIP)
- Python Basics
  - The first program
  - Docstrings
  - Blocks and indentation
  - First Control structures
- Simple data types and expressions
  - Boolean
  - Integer
  - Float
  - Complex numbers
  - Strings
  - Bytes
- More data types
  - Lists
  - Tuples
  - Sets
  - Dictionaries
  - Strings
  - Numpy
  - Arrays

- Control structures
  - Loops
  - Alternatives
  - Exceptions
- Comprehension and slicing
- Object oriented Python
  - Class definition
  - Class instantiation
  - Generators and iterators
- Files
  - Files
  - Serialization
  - Important file formats
- Specialized topics (optional)
  - Writing and installing your own libraries
  - Regular expressions

ESIGELEC
SCHOOL OF ENGINEERING
SMART AND CONNECTED SYSTEMS

ESIGELEC, Technopôle du Madrillet, Avenue Galilée BP10024,
76801 Saint-Etienne du Rouvray - CEDEX France
Phone: +33 (0)2 32 91 58 58 | www.esigelec.fr

BIENVENUE EN FRANCE