

# IE.3507 Automatics and real-time systems

## General information

Course title: Automatics and real-time systems Course ID : IE.3507 Person in charge : Alexis BRENES ECTS : 5 Average amount of work by student : 150 hours among which 50 tutored hours Teamwork and individual work Keywords : Control command, control loop, process, waiting line, semaphore, real time Classroom with computers and MATLAB/Simulink
--

## Presentation

*This course focuses on control and command of systems. To that purpose, two disciplines are presented: Automatics and Real-Time systems.*

*Automatics is the science at the heart of information processing. It consists in processing data coming from sensors in order to control outputs. The systems of interest are mainly in the field of aeronautics, networks, robotics, biology or even economics.*

*The algorithms defined by automatics engineers are executed on multitask systems that must fulfill stringent constraints of time and execution triggers that are consistent with the application.*

*In the first part, this course presents the basics of automatics applied to embedded systems, explores several concepts like system robustness and exposes up-to-date problems. The second part of this course deals with the principles of real-time systems, based on the single-processor use case.*

*The objectives, for the ISEP engineer are to be able to:*

- Communicate properly with a team of system engineer or automatics experts,
- Choose methods and control techniques which are appropriate to solve a given technical problem related to control,
- Implement these techniques on simple examples in order to become autonomous when dealing with more complex problems.

*This course is divided into theoretical and practical sessions. The « automatics » part deals with the implementation of technical solution, evaluated and tested with MATLAB/Simulink.*

## Pedagogical objectives

### Relationship with the ISEP competence referential

Specialized competences

- Solve multidisciplinary scientific and technical problems under constraint in the field of information technology
  - Analyze the problem and take the constraints into account
    - Interpret and delimit the problem
    - Explore and analyze the options for resolution
  - Evaluation of the solutions
    - Determine complete and consistent choice criteria
    - Be critical

- Opt for an optimal solution
- Design a technological software or hardware with secure and normalized behavior
  - Manage the conception phases
    - Determine the good system-level approach considering the overall system architecture
    - Manage the conditions and know how to switch from one system level to another
    - Specify the operating conditions in test mode
    - Validate the design
  - Analyze how the system works and its failure
- Act properly in a project
  - Manage the overall project : the different entities and the relationships between them
  - Act as a projet manager
    - Make optimal and appropriate technological choices

General and transversal competences:

- Act as a dynamic and efficient group member
  - Work in a team with cultural
  - Be proactive
- Communicate properly in a scientific and technical environnement with international collaboration
  - Listen and be listened to
  - Converse, argue and convince
  - Communicate in several languages
  - Document efficiently

At the end of the course, the students will have:

- Solved scientific and technical projects under constraint :
  - Analyzed command problems and taken into account the constraints associated to the problems
  - Explored and delimited the options for resolution
  - Modelled the information, more particularly in the context of embedded systems
  - Analyzed several criterion choices to evaluate several possible options
  - Validate the design
- Understood task scheduling in a real-time system
- Understood the parameters of interest for execution
- Operated the communication mechanisms between tasks
- Used libraries allowing to implement communication protocols between specific components (drivers)
- Communicated, read and written documents in English in a culturally-diverse environment
- Assimilated technical terms to understand the documentation and the challenges related to automatics and real-time systems.

## Prerequisites

Automatics part : Fundamental mathematical tools : Linear Algebra (matrices), Fourier transform, Laplace transform.

Real-time part : Programming in C and information systems (IE.2410).

## Content

The course will deal with the following concepts:

- Notion of system
- State space
- Optimal control theory
- Parameter identification
- State variables
- Optimization et frequential synthesis
- Taking into account random phenomena
- Scheduling
- Modeling,
- Time-domain constraints,
- Real-time multitask systems,
- Synchronzation,
- Communication between tasks,
- Sytem programs,
- Drivers

### **Tools under use by the teachers**

The teachers will use the following tools:

- System modeling and analysis (Matlab)
- Time-domain simulation (Simulink)
- Evaluation boards and microcontroller systems for cross-development

### **Tools under use by the students**

Same

## Pedagogy

### **Teaching organization**

This course is divided into :

- Exercices and case studies to improve concept assimilation,
- Practical sessions with MATLAB/Simulink
- Practical sessions on microcontroller boards with discrete components.

### **Evaluation**

The marks will be computed as follows:

- 50% on the automatics part among which :
  - o 50% on the practical sessions
  - o 50% on the final exam
- 50% on the real-time part

The competences will be evaluated, for the automatics part, by:

- Reports on the lab sessions (at least 3) with a continuous feedback and mark after each lab session
- A final exam at the end of the semester

For the real-time part:

- Presentation of mini-projects (40%)
- Exercises (10%)
- Practical sessions on microcontroller board (50%)

## **Language**

Everything including courses, lab sessions and reports to deliver will be in English

## **References**

Course slides (Moodle), Web links and all documents from the course will be available to the students online.