EMBEDDED ELECTRONICS

Practical Work in Control	3 credits	35h
Energy management for embedded systems	3 credits	40h
Discrete and Continuous Systems Optimisation	6 credits	68h
Tutored projects	4 credits	60h
Improving autonomy and building a professional project	4 credits	39h
Improve your management abilities	4 credits	45h
Object oriented and real time programming	6 credits	

Practical Work in Control

ECTS
3 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
35h

Presentation

Description

This teaching includes 6 laboratories and a project. From these experiments, the students address the main problems stated by the study of real systems (tanks, temperature control, robot, segway.), but also handle several simulation and developpment tools (Matlab, XPCTarget, Keil....).

Organisation: Semester 2

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

This practical teaching illustrates all the courses in automatic control during the 4the year at INSA (numerical control, non linear systems, optimal control, multivariate control, graph).

The student will be able to:

* Model/identify a system
* Synthesize a control following specifications (performance) and implement it
* be critical on a command
* write a report

Pre-requisites

Non-linear control - Optimal control -Multi-variables systems - Digital control -

Useful info

Place

> Toulouse

Energy management for embedded systems

ECTS
3 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
40h

Presentation

Description

Ragone chart, power and energy density of various sources (primary and secondary batteries, fuel cells...)

Photovoltaic panels, thermogenerators, piezoelectric generators...

MPPT, multi-sources, auto-powering circuits ...

Composition of a DC machine with brushes; relations between external voltage and speed, between the electromagnetic torque and the current, torque to speed characteristic; electrical and mechanical equations for transient behavior; machine block diagram. Single-phase transformer; equations and electrical models; equivalent diagrams. Single and three phase diode rectifiers, instantaneous rectified voltage and average voltage; period and ripple rate; diodes sizing, power factor. Choppers, buck, boost, half and full bridge; continuous and discontinuous conduction mode; control strategies, power components for hard switching modes.

Organisation:

- The principles and theoretical basis are presented in lectures using Power Point slides whose copies are provided to students.

- In the tutorials case studies are presented for the design of certain specific elements such as machine parameters, transformer models, rectifier and converter. A handout of the tutorials is provided to students.

- The labworks deal with generation of PWM control signals for a chopper and the waveforms of current and voltage resulting in an inductive load. The H bridge is also controlled as a multilevel DC-AC inverter and an audio amplification application (class D) is implemented. Another part is devoted to the control via a microcontroller to a synchronous motor (brushless DC), this part has equal modeling with Matlab and Spice

Objectives

- At the end of this module, the student will have understood and be able to explain (main concepts):

- The performances of energy sources likely to be used in embedded systems,

- The methods of energy capture (harvesting / scavenging)

- circuit topologies for embedded energy management,

- The operation mode of a classical DC motor (actuator) as well as its electrical and mechanical characteristics.

- The operation mode of a AC transformer and its associated electrical models.

- The main structures and electrical characteristics of single and three phase rectifiers.

- The main structures of choppers, their properties, their reversibility and control strategies.

- The principle of torque and/or speed control of a DC machine using a chopper

The student will be able to:

- Analyze the energy requirements of an embedded system and to devise a solution,

- Analyze a mechanical system and identify its needs for motorizing, the type of converter that should be associated with the actuator.

- Dimension the elements of the electrical energy conversion chain which will drive the actuator.

- Choose the control strategy for the electronic switches of the converter in order to ensure its reliability.

Pre-requisites

General knowledge of electricity, alternating current, electrical circuits, analog and digital electronics as well as mathematical tools (Fourier and Laplace transforms) and the basics of automatic control (transfer functions and block diagrams).

Useful info

Place

> Toulouse

Discrete and Continuous Systems Optimisation

ECTS
6 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
68h

Presentation

Description

Programme (detailed contents):

Linear programming basic concepts – Graph modelling and algorithms for paths search, trees and maximal flows. Branch and bounds methods. Application areas: allocation, transportation, production planning and scheduling.

- Markov chains with continuous and discrete time. Basic queuing systems. Performance evaluation. Applications: computer and industrial systems.

- Basic concepts of Petri Nets – analysis by marking enumeration - Structural analysis- Applications: computer and industrial systems.

- Main concepts of nonlinear programming without and with constraints (equality or inequality types).

- Application to the control of linear systems with quadratic criterion (LGR, LQG) to reach to the resolution of Riccati equations. A parallel is performed with Model Predictive Control seen as a quadratic optimization problem on a finite horizon.

- Application to the dynamic programming

Documents:

- Lecture notes on "Linear programming, Graphs and network theory"

- Lecture notes on "Stochastic processes and queuing systems"

- Lecture notes on "Petri nets"

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

- different approaches to analyse, evaluate the performance of discrete event systems through different models (deterministic or stochastic, graphs) and to optimise them (linear programming)

- the optimisation methods for continuous systems :

  -static (first and second order conditions)

  - dynamic (dynamic programming)

  - their applications to optimal or model predictive control

  mainly for linear systems

The student will be able to:

- to analyse, model and solve an optimization problem of discrete systems by a linear programming or a graph, by applying relevant algorithms (simplex or usual graphs and networks algorithms)

- to model and to characterize: stationary Makovian processes with discrete state space (chains) and continuous or discrete time, queuing systems, to analyse their transient and stationary behaviours, to evaluate their performances

- to model and analyse discrete event systems by Petri nets

- to formalise and solve a quadratic criterion, nonlinear, without or with constraints optimisation problem in the case of systems with real variables

-to develop and design an optimal control law (LQG) for a linear or linearized process.

Pre-requisites

Linear algebra - Probabilities - Dynamic systems (state concept). Basic elements in

logic systems and Petri nets.

Useful info

Place

> Toulouse

Tutored projects

ECTS
4 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
60h

Presentation

Description

The work is composed of two parts :

* a bibliographical study dealing with a research theme in relationship with the project. This study is concluded by the witting of a document whose content and form have to follow the recommendations given by the tutors,
* a technical realization which is performed during a full semester.

Organisation:

4 hours of documentary research teaching then 10 hours of project management teaching, then 30h of project.

Objectives

The module is aimed at motivating students with research activities by means "tutored projects" involving groups of several students and directed by an academic or an industrial tutor. Those projects are completed by a formation to documentary research. A course of project management allows guiding the realisation part of the project.

At the end of this module, the student will have understood and be able to explain (main concepts):

* the concepts, norms and techniques related to the building of a state of the art in relationship with the subject of the project subject,
* the concepts and techniques in relationship with the management of the project involving several persons.

The student will be able to:

* elaborate a state of the art dealing with a domain in relationship with the project,
* manage a project involving several persons,
* integrate techniques of different scientific domains to reach the realization goals of the project.

Pre-requisites

Depends of the subject of the project.

Useful info

Contacts

Education manager

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Place

- Toulouse

Improving autonomy and building a professional project

ECTS
4 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
39h

Presentation

Objectives

Construire une équipe projet, Approfondir ses connaissances,

Investir le métier, les domaines d'activité, les fonctions.

L'étudiant devra être capable de :

- d'analyser avec les autres un problème posé (Identifier le problème, définir les axes d'approche dans un bilan interactif : organisation, physique, technique, stratégique, motivation, confiance...

- de décider ensemble (permettre à tout le monde d'exprimer son avis, ajuster et réguler sa conduite en fonction de l'analyse collective),

- d'identifier les ressources du groupe (sens critique, repérage des points forts et faibles de chacun).

Useful info

Place

- Toulouse

Improve your management abilities

ECTS
4 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
45h

Presentation

Objectives

At the end of this module, the student will have understood and be able to explain :

* The basic rules of business law

* The objectives, principles and means of marketing

* The principles and procedures of financial diagnosis and / or investment

The student will be able to :

Apply principles and rules of management and law in simple situations. Take into account the parameters of the management (customer needs, cost effectiveness and legal compliance).

Useful info

Contacts

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Place

> Toulouse

Object oriented and real time programming

ECTS
6 credits

Presentation

Description

Program (detailed contents):

The module addresses the specification and design of real time systems, an introduction to main real-time operating systems services, method to program and to test a real-time application.

The construction of programs requiring the basic notions of C++ and java: class, constructor, protection, inheritance, overload, polymorphism and genericity wil be explain. Some extra Library will be used.

Organisation:

Lectures and lab work are mixed.

Main difficulties for students:

· use of parallel computing · Master the multitasking side of applications · understand the different concepts of object programming.

Objectives

This module presents real time systems, concepts, attributes, constraints, applications, and teach how to program these systems using object oriented languages and using real time operating systems. The concepts of the programming object and the use of programming language will be described.

Useful info

Contacts

Education manager

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