Autumn semester

MECHANICAL ENGINEERING COURSES

System level modelling and simulation	3 credits	30h
Composite structures and case study	3 credits	46h
Heat Engines, Refrigerators and Heat Pumps	3 credits	38h
Non destructive testing/English	4 credits	55h
Research projects (part 3)	4 credits	60h
Optional modulus	7 credits	90h
Human Resources Management and Group Work	6 credits	75h

SYSTEM ENGINEERING COURSES

Dependable systems	5 credits	68,5h
Multidisciplinary design	4 credits	44h
Thermal engines and systems	4 credits	57h
Systems on chip	4 credits	50h
Industrialization and logistics	5 credits	60h
Human Resources Management and Group Work	6 credits	75h
Research project and Industrial property	6 credits	56h

System level modelling and simulation

Level
BAC +4

ECTS
3 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
30h

Presentation

Description

This course is dedicated to the lumped parameters modelling and simulation of power systems. The methodology and the analysis is supported by the Bond-Graph formalism. A progressive approach leads the student to acquire knowledge and practical know-how in muti-domain modelling (models structures, adaptation to simulation software, link with distributed models and inverse problems).

Practicals are based on up-to-date industrial examples that are simulated within both

Matlab/Simulink, AMESim and DymoLa.

Organization:

Lecture/tutorials plus practicals

Main difficulties for students:

Establishing multiphysics path, understanding the need.

Objectives

The student will be able to build, simulate and analyse system-level models of multi-domain power systems.

Pre-requisites

Dynamic systems, fluid mechanics, solid rigid mechanics, dynamic systems

Useful info

Place

Toulouse

Composite structures and case study

Level
BAC +4

ECTS
3 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
46h

Presentation

Description

A general course (16.25 h) to the whole group is given on laminate theory and technos. A handout deals with simple and more complex issues of composite theories. A general presentation deals on technos.

Organization:

* A project on an aeronautic case study is done within 6 courses of 3h each and deals with basic static sizing, damage tolerance design and manufacturing.
* The project is done by pair under the supervision of academic or senior engineer.
* 6h of CATIA Composite are also done to study practical composite design rules of aeronautic industry.
* Two practical works of 3h each enables to manufacture composite plates by hand stacking or LRI.

Objectives

Main Objectives :

The student will be able to perform simple sizing of composite structures and to choice a couple manufacturing/material for a given case study.

The student will be able to:

* Choice a couple of fibers and matrix and their commercial products.
* Choice a type of composite structure: laminates, sandwichs, 2D1/2,3D, 4D.
* Determine the manufacturing method: hand layup, fiber placement, RTM, LRI, RFI.
* To be inspired by solutions of automotive, naval, wind energy or aerospace industry.
* To be inspired by past experience in aeronautic industry.
* Know and use laminate theory.
* Knows and use simple sizing of junctions.
* Know issues of impact and ageing.
* Know issues of failure and damage.
* Realize a case study : example wing box of an acrobatic aircraft.
* Make a presentation of their sizing and their design.
* Work in a collaborative manner.

Pre-requisites

- Beam theory, Continuum mechanics, Materials behaviors.

- Matrix calculation.

Useful info

Place

Toulouse

Heat Engines, Refrigerators and Heat Pumps

Level
BAC +4

ECTS
3 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
38h

Presentation

Description

With appropriate reminders and complements of thermodynamics, this course focuses on the behaviour of various industrial thermal systems :

- engines with continuous mass transfer (compressors, turbines...),

- condensable steam engines (steam-powered engines, refrigerating and heat pumps...), with the objective to optimize them, notably from an energetic efficiency point of view.

Organization:

- 8 lectures provide the necessary thermodynamic knowledge for modelling heat engines, refrigerators and heat pumps.

- 13 tutorial sessions deal with various problems. Students should prepare for these sessions in advance for maximum efficiency and personalization of interactions with the teacher. They have at their disposal a booklet gathering the problems and the tables and graphs necessary for their resolution.

- 3 lab work sessions devoted to the study of a compressor, a heat pump and an air handling unit complete the course.

Objectives

At the end of this course, the student should have understood and will be able to explain the operation of conventional heat engines, refrigerators and heat pumps as well as the basics of combustion.

The student should be able to size and optimize conventional heat engines, refrigerators and heat pumps.

Pre-requisites

Fundamentals in thermodynamics (1st year)

Thermodynamics and Thermodynamic Analysis (1st year)

Useful info

Place

Toulouse

Non destructive testing/English

Level
BAC +4

ECTS
4 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
55h

In brief

Teaching language(s): Français, Anglais

Presentation

Description

Syllabus (detailed contents):

Module 1 : Non Destructive testing (NDT)

Theory of testing and defect analysis.

Analysis of the link between industrial production and defects as well as between defects and the mechanical behaviour of items.

The main nondestructive testing methods are introduced:

- Dye penetration and Magnetoscopy

- Eddy currents: corresponding fundamentals in physics, applications to defect detection.

- Ultrasonic testing: corresponding fundamentals in physics, industrial applications.

- radiology (X-ray and gamma): corresponding fundamentals in physics, radiation safety, industrial applications.

Module 2 : Metallic alloys for high temperature applications – Creep behaviour

Creep phenomena and resistance.

Creep modelling to determine life expectancy: Norton's law and Larson-Miller parameters.

High temperature metallic alloys : properties and applications.

Module 3 : English

The students, organized in small groups, are tutored by English teachers while writing abstracts and preparing short oral presentations bearing on each of the nondestructive methods. The stress is put on student autonomy and constructive feedback from the English teachers.

Objectives

At the end of this module, the student will have

understood and be able to explain (main concepts):

Module 1 : Non Destructive testing (NDT)

Students have to know the main nondestructive testing methods with advantages/drawbacks and how to apply them to practical industrial cases. They must be able to choose the most appropriate method to solve specific industrial issues.

Module 2 : Metallic alloys for high temperature applications – Creep behaviour

Analysis of the physics occurring during creep and of the parameters which affect creep resistance.

How to apply basic theoretical models to calculate rupture life expectancy.

Knowledge of the main metallic alloys withstanding creep at high temperatures.

Module 3 : English

Students must be able to organize their scientific speech and writing logically, to use proper English in a concise and appropriate style while meeting genre conventions; master technical terms ; resort to appropriate registers (specialized/non specialized audiences/readers) and quote scientific sources according to international citation standards.

Pre-requisites

Module 1 : Nondestructive testing (NDT)

L1, 2 and 3 courses or equivalent : knowledge of fundamental principles in physics i.e. electricity, electromagnetism, optics, atomic structure and Materials Science.

Module 2 : Metallic alloys for high temperature applications - Creep behaviour

Mechanics of Materials : defects in metallic materials and plastic deformation mechanism ; behaviour of materials.

Module 3 : English

Students must master general English and know how to write and talk about general scientific elements in a rigorous way (1st,2nd, 3rd & 4th year English courses).

Useful info

Place

Toulouse

Research projects (part 3)

Level
BAC +4

ECTS
4 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
60h

In brief

Teaching language(s): Français, Anglais

Presentation

Description

Complete and analyse a realization which is performed during a full semester.

Organization : 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.

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

- the concepts and techniques in relationship with the management of the research project involving several persons.

The student will be able to :

- finalize a research project involving several persons,

- integrate scientific approaches and techniques of different scientific domains to meet the realization goals of the research project.

Useful info

Contacts

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Place

Toulouse

Optional modulus

Level
BAC +4

ECTS
7 credits

Number of hours
90h

In brief

Teaching language(s): Français, Anglais

Presentation

Description

The module is composed of 3 sub-modules of 30h each to be elected by students among a proposed list.

The modules enable students to develop their ability to research work or to increase their knowledge on issues related to mechanical engineering such as :

- production management, maintenance, modeling of flow

- configuration management, special industrialization techniques,

- compressible fluid mechanics, microfluidics, turbomachines, computational fluid dynamics,

- hydraulic systems and components,

- nonlinear FEA, optimal design, multiaxial fatigue, digital mock-up, HSM optimization.

Objectives

The student will be able to successfully follow 4 optional modules related to mechanical design skills.

Useful info

Contacts

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Human Resources Management and Group Work

ECTS
6 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
75h

Presentation

Objectives

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

Human Resource Management

Aims and organisation of a Human Resources position, job analysis and forecasting, recruiting, work motivation, skills, salary, training, career management, conflict mitigation, work contract

Social Psychology

Groups, what they are, their influences and dynamics

The student will be able to analyse a group situation

Pre-requisites

None

Place

Toulouse

Useful info

Dependable systems

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
68,5h

Presentation

Objectives

At the end of this module, the student will have understood and be able to explain the notions associated with the concepts of risk, dependability and quality as well as the tasks of the associated Management process and their implementations. The student will have to perceive the importance of the continuous improvement of the management activities (Management System).The student will be able to identify the hindrances to safety and quality, to evaluate them and to select the adequate methods to handle these issues.

Useful info

Contacts

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Place

Toulouse

Multidisciplinary design

Level
BAC +4

ECTS
4 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
44h

Presentation

Description

Design of Experiment (DoE)

Accounts.- Practical exercices.- Practical work using Explaser, an interactive simulator of industrial process : to solve a multi parameter problem of laser soldering. In a first stage, all calculations are made by hand without any helps of softwares, in order to understand the mechanic of the calculations and the manner of establishing effect graphisms of factors and of their interactions.- Application of the method to the improvement of a catapult : the Statapult.

Surrogate models and sizing of mechatronic systems

The lectures take the forms of videos (moodle SPOC) and interactive quiz.

Program: design drivers, sizing scenarios, surrogate models, estimation models with scaling laws, life time evaluation, profil mission simulation, optimization, sizing procedure definition, numerical solver.

Projects examples: Optimal preliminary design of thrust vector control actuation system (Ariane, Vega), supercapacitor charge converter (chopper), flight control actuator (spoiler, aileron), last mile delivery electric vehicle...

Objectives

Design of experiments

To know the global concepts of DoE and understand the interest of the tool.

Surrogate models and sizing of mechatronic systems

To explain the process and the different models usefull for the optimal sizing of mechatronic systems.

The student will be able to:

Design of experiments

- To be able to define and set into work some tests allowing to get an optimistic process.
- To carry out one's own design of experiments.

Surrogate models and sizing of mechatronic systems

- To define the sizing scenarios of a technical system

- To establish the estimation models and simulation modes of the set of components

- To set a design procedure and to define the optimization problem

- To Implement the calculations in a numerical environment

Pre-requisites

Probability (basic), statistics (basic), notions of system architecture (mechanical, hydraulic, electric, etc.)

Useful info

Contacts

Education manager
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Place

Toulouse

Thermal engines and systems

ECTS
4 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
57h

Presentation

Description

Thermal engines : First, a reminder of the principles of thermodynamics, fluid modeling, thermodynamic transformations (isobar, isoenthalp, adiabatic, etc.). Secondly, analysis of the thermodynamic cycles of steam engines, gas turbines and heat pumps.

Thermal systems : Lumped parameter modeling of components involved in thermal engines and systems such as heat exchangers, compressors, turbines, valves. Case study on an air conditioning and pressurization system for an aircraft.

Computational fluid mechanics : Initiation to the CFD code Fluent. Numerical simulation of one of the components of a thermal system, in the framework of a project done by groups of 2 students.

Objectives

At the end of this module, the student should have understood and be able to analyze thermal and mechanical energy production systems and their associated components.

The student should be able to:

- Analyze the thermodynamic cycle associated with a power plant.
- Size a thermal engine to meet specifications in terms of requested power.
- Specify the components of a thermal engine or system.
- Calculate the air conditioning flow requirements to

perform various functions (pressurization, fresh air renewal, heating, cooling) in an aircraft and adjust the recirculation and the flow distribution between the different cabin zones.

Pre-requisites

Basics of thermodynamics and heat transfer.

Useful info

Contacts

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Place

Toulouse

Systems on chip

ECTS
4 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
50h

Presentation

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):-the design and optimisation of advanced digital systems-the life cycle of a software-hardware system (specifications, design, implementation)-co-design of software hardware complex systems upon the application requests-co-verification of new software ¿ hardware complex systemsThe student will be able to:-design and implement advanced digital systems on FPGA using VHDL and optimise their performances in power consumption and functioning frequency upon the application requests-design and implement hardware and software systems on programmable chips (SoPC) and systems on chip (SoC)

Pre-requisites

Computer engineering

Exigencies engineering

Place

Toulouse

Useful info

Industrialization and logistics

Level
BAC +4

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
60h

Presentation

Description

Industrialization :

Through two types of industrialization : The automotive and aerospace ; we detail :

- The different types of production management organizations

- Industrial measures implemented

- Piloting of industrialization : PLM , ERP, PDM , MES, lean management

- Design and simulation of the system of industrialization

- Introduction to CAD and CAM Catia V5

Labwork of optimization of production and organization and production management

Visits to factories and conference on lean management

Organization : 5 hours of lectures, 10.25h of Tutorials , 8h of Labwork, 3h conference, examen: 1.25 MCT

Production management, planning, scheduling :

Production management and logistics

linear programming applied to planning

Graphs and scheduling application

Scheduling and combinatorial optimization

Production Planning

Labwork : Introduction to AMPL and Excel

Organization : 12.5 hours of lectures, 2.5h of Tutorials , 2.5h of Labwork, examen: 1.25h

Configuration Management :

1 – Airbus world (Aircraft families, industrial roles accros Europe, all different maturity steps of a program)

2 – Configuration management generalities (first look and presentation of modules that will be detailed afterwards)

3 – Product structure (What is product structure, how it is built and what are the main rules)

4 – The change process (all different steps of a change request during the full process, data and deliverables requiered pending on progress in the process)

5 – Offer management (what is offer management and what are the associated deliverables)

6 – Attestation and control of conformity (Delta managements)

Organization: 6 x 2h30 of course + 2 x 2h30 of labwork + 2h of exam

Objectives

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

The organization , management and control of a system of industrialization

The challenges of production management (PM) and supply chain (SCM) as well as issues of scheduling

What is configuration management, what are the enablers and what is the purpose

The student will be able to :

- Define the industrial means used and the type of production management organization associated with the system of industrialization
- Define the tools to control it : PLM , ERP, PDM , MES, the lean management
- Use tools for design and simulation of industrialization : CAD and CAM CATIA
- Use of models, methods and tools GP , SCM, and scheduling
- Roughly describe airbus world (A/Cs family, industrial sharing across the Europe)
- Define a hierarchical & appropriated breakdown of a complex product
- Apply the change process and identify required data to allow decision
- Identify mechanisms that enable management of product offer and its customisation
- Demonstrate that final product manufactured is conform to expectations

Pre-requisites

Reading of plans, current metallic materials, various types of machining.

Basic elements on : probabilities – Linear programming.

Useful info

Contacts

Education manager
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Place

Toulouse

Research project and Industrial property

ECTS
6 credits

Number of hours
56h

Presentation

Objectives

Industrial Property

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

Major differences between intellectual and industrial properties. He must be able to initiate protections by himself by addressing the right people with regard to his inventive activity and his need for protection. He will have to know the costs and limitations.

The student must be able to :

- describe the different types of protections available

- define the legal framework of each protection and the modalities of application

- understand the different protection strategies associated with patents, disclosure or secrecy

- to know and virtually identify the corporate strategies associated with the defense and exploitation of industrial property : "Patent Pool" strategy. Know how to explain the advantages and disadvantages of each strategy

-know the major protection organizations, their respective roles in order to make good decisions about their protection needs

-know how to initiate the steps to protect an invention, a brand, a drawing, a model, a domain name, a book, a musical composition, a computer program, or any other discovery. Know the time, costs, temporal and geographical limitations.

Useful info

Contacts

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