study Programme

Electrical Engineering

2023-2024

MANUAL STUDY PLAN

&

MODULE SHEETS

Electrical Engineering Program

The Electrical Engineering program at EPI-Polytechnic Sousse is designed to prepare high-level engineers with

the competencies required to design, implement, and manage electronic systems, encompassing both hardware and software dimensions. The program aims to:

1**. Build Expertise in Core Domains**

Provide in-depth knowledge in analog and digital electronics, embedded systems, automation, radiocommunication, and signal and image processing, ensuring a solid technical foundation.

2. Foster Interdisciplinary Skills

Develop the ability to integrate knowledge from various domains such as telecommunications,

microelectronics, multimedia, and mechatronics to solve complex engineering problems.

3. Prepare for Specialized Career Paths

Enable students to specialize in areas like embedded systems, biomedical instrumentation, or industrial

control, equipping them with advanced technical expertise tailored to industry needs.

4. Promote Innovation and Research

Train engineers capable of contributing to technological advancements through innovation, applied

research, and the adoption of emerging technologies.

5. Encourage Competence in System Design

Develop the skills required to design, simulate, and optimize electronic and electromechanical systems

for industries such as automotive, aeronautics, biomedical, and more.

6. Ensure Leadership and Management Proficiency

Train engineers to lead projects, manage teams, and mobilize resources effectively in multidisciplinary

industrial environments.

7. Incorporate Ethical and Sustainable Practices

Promote ethical responsibility and sustainability in engineering practices, ensuring designs respect

environmental and safety standards.

8. Support Lifelong Learning

Encourage continuous learning to adapt to evolving technologies and remain competitive in a globalized

engineering landscape.

9. Provide Real-World Experience

Offer practical training through industry partnerships, internships, and applied projects to bridge the gap between theoretical knowledge and industrial applications.

The Electrical Engineering program offers specialization that lasts two semesters and where the student is oriented to one of the following three specialty:

1- Embedded networks and systems
2- Biomedical instrumentation
3- Industrial control

Electrical Engineering Study Plan

Electrical Engineering : Common Core : S1

Code	Subject	Coef	Credit	Course/week	Practical/week
FR-ABC	French	1,5	2	1,5	0
FR-ABC	English	1,5	2	1,5	0
ELEC 3 103	Electrical Networks	2,25	3	1,5	0,75
ELEC 3 104	Electrical schematics & Installation	3	3	1,5	1,5
ELEC 3 105	Linear Systems 1	3	3	2,25	0,75
ELEC 3 106	Signal processing 1	3	3	2,25	0,75
ELEC 3 107	Discrete component electronics	1,5	3	1,5	0,75
ELEC 3 108	Functions for Digital Electronics	1,5	3	1,5	0,75
ELEC 3 109	Electrical circuits	2,25	3	1,5	0,75
ELEC 3 110	Computer architecture and Linux	1,5	2	1,5	0
ELEC 3 111	Mathematics for engineers	3	3	1,5	0
	Total	24	**30**		

Electrical Engineering : Common Core : S2

Code	Subject	Coef	Credit	Course/week	Practical/week
FR-ABC	French	1,5	2	1,5	0
FR-ABC	English	1,5	2	1,5	0
ELEC 3 203	Direct current machines	3	3	1,5	0.75
ELEC 3 204	Electrical installation LAB	1,5	3	0	1,5
ELEC 3 205	Linear systems 2	1,5	2	1,5	0.75
ELEC 3 206	Signal processing 2	1,5	2	1,5	0,75
ELEC 3 207	Functions & Electronic Systems	3	3	1,5	0,75
ELEC 3 208	Object Oriented Programming C++ & Java	3	3	0	1,5
ELEC 3 209	Microprocessor and microcontroller engineering	3	3	1,5	1,5
ELEC 3 210	CAD (Computer Aided Design)	1,5	3	0	3
ELEC 3 211	Probability & Statistics	1,5	2	1,5	0
ELEC 3 212	Numerical analysis	1,5	2	1,5	0
	Total	24	30		

Electrical Engineering : Common Core : S3

Code	Subject	Coef	Credit	Course/week	Practical/week
FR-ABC	French	1,5	2	1,5	0
ENG-ABC	English	1,5	2	1,5	0
ELEC 4 103	AC machines	3,00	3	1.5	1.5
ELEC 4 104	power electronics 1	2,25	3	1,5	0,75
ELEC 4 105	industrial automation and IPA	3,00	3	1,5	1,5
ELEC 4 106	system analysis and control	2,25	3	1,5	0,75
ELEC 4 107	advanced techniques	1,50	2	1,5	0
ELEC 4 108	Programming and embedded systems engineering	1,50	2	0	1.5
ELEC 4 109	signal transmission	1,50	2	1,5	0
ELEC 4 110	sensors and actuators	1,50	2	1,5	0
ELEC 4 111	programmable circuits	1,50	2	1,5	0
ELEC 4 112	lab view	1,50	2	1,5	0
TV-401	MOS certification	1,50	2	0	1,5
	Total	24	30		

Embedded systems Major : S4

Code	Subject	Coef	Credit	Course/week	Practical/week
FR-ABC	French	1,5	2	1,5	0
ENG-ABC	English	1,5	2	1,5	0
ELEC-SE 4 203	Power electronics 2	2,25	3	1,5	0,75
ELEC-SE 4 204	VHDL synthesis and technology	2,25	3	1,5	0,75
ELEC-SE 4 205	DSP : Architecture and programming	1,5	2	1,5	0
ELEC-SE 4 206	Image processing	3	3	2	1
ELEC-SE 4 207	Interfacing techniques	1,5	2	0	1,5
ELEC-SE 4 208	Embedded systems for IoT 1	1,5	2	1,5	0
ELEC-SE 4 209	Smart Sensors	1,5	2	0.75	0.75
ELEC-SE 4 210	Embedded mobile development	1,5	2	1,5	0,75
ELEC-SE 4 211	New technologies for process control	1,5	2	0	1,5
ELEC-SE 4 212	Pyton programming for embedded systems	1,5	2	0	1,5
TV-402	PFA (end of year project)	3	3	0	2,25
	Total	24	**30**		

Industrial Control Major : S4

Code	Subject	Coef	Credit	Course/week	Practical/week
FR-ABC	French	1,5	2	1,5	0
ENG-ABC	English	1,5	2	1,5	0
ELEC-CI 4 203	Power electronics 2	2,25	3	1,5	0,75
ELEC-CI 4 204	VHDL synthesis and technology	2,25	3	1,5	0,75
ELEC-CI 4 205	DSP : Architecture and programming	1,5	2	1,5	0
ELEC-CI 4 206	Image processing	3	3	2	1
ELEC-CI 4 207	Interfacing techniques	1,5	2	0	1,5
ELEC-CI 4 208	Embedded systems for IoT 1	1,5	2	1,5	0
ELEC-CI 4 209	Robotics	1,5	2	1,5	0
ELEC-CI 4 210	Control and HMI of Industrial Systems	1,5	2	0	1,5
ELEC-CI 4 211	Modeling of electrical machines	1,5	2	1,5	0
ELEC-CI 4 212	Smart control	1,5	2	1,5	0,75
TV-402	PFA (end of year project)	3	3	0	2,25
	Total	24	**30**		

Biomedical Instrumentation Major : S4

Code	Subject	Coef	Credit	Course/week	Practical/week
FR-ABC	French	1,5	2	1,5	0
ENG-ABC	English	1,5	2	1,5	0
ELEC-IB 4 203	Power electronics 2	2,25	3	1,5	0,75
ELEC-IB 4 204	VHDL synthesis and technology	2,25	3	1,5	0,75
ELEC-IB 4 205	DSP : Architecture and programming	1,5	2	1,5	0
ELEC-IB 4 206	Image processing	3	3	2	1
ELEC-IB 4 207	Interfacing techniques	1,5	2	0	1,5
ELEC-IB 4 208	Embedded systems for IoT 1	1,5	2	1,5	0
ELEC-IB 4 209	Equipment maintenance 1	1,5	2	1,5	0,75
ELEC-IB 4 210	Safety, Maintenance and Sterilization of Biomedical Equipment	1.5	2	1,5	0
ELEC-IB 4 211	Cell Biology and Microbiology applied to Biotechnology	1.5	2	1,5	0
ELEC-IB 4 212	Fundamentals of Anatomy, Physiology and Neurophysiology for Medical Instrumentation	1,5	2	1,5	0
TV-402	PFA (end of year project)	3	3	0	2,25
	Total	24	**30**		

Embedded systems Major: S5

Code	Subject	Coef	Credit	Course/week	Practical/week
TV-501	GRH	1,5	2	1,5	0
TV-502	Labor law	1,5	2	1,5	0
TV-503	preparation for certification in Entrepreneurship	1,5	2	1,5	0
ELEC-SE 5 101	Embedded systems for IoT 2	1.5	3	1.5	0.75
ELEC-SE 5 102	Artificial and Industrial Vision	1.5	2	1.5	0.75
ELEC-SE 5 103	Embedded systems security	3	3	1.5	0.75
ELEC-SE 5 104	VHDL : architecture and simulation	3	3	1.5	0.75
ELEC-SE 5 105	SOC prototyping on FPGA	1.5	2	1.5	0.75
ELEC-SE 5 106	ARM processors and applications	1.5	2	0	1.5
ELEC-SE 5 107	Embedded Artificial Intelligence	3	3	1.5	0.75
ELEC-SE 5 108	RFID: Radio Frequency Identification	1.5	2	0	1.5
ELEC-SE 5 109	Industry 4.0	1.5	2	0	1.5
ELEC-SE 5 110	Quality management	1.5	2	1.5	0
	Total	24	30		

Industrial Control Major: S5

Coded	Subject	Coef	Credit	Course/ week	Practical / week
TV-501	GRH	1.5	2	1.5	0
TV-502	Labor law	1.5	2	1.5	0
TV-503	preparation for certification in Entrepreneurship	1.5	2	1.5	0
ELEC-CI 5 101	Control of electrical machines	3	3	1.5	0.75
ELEC-CI 5 102	Design office	1.5	2	0	1.5
ELEC-CI 5 103	Industry 4.0	1.5	2	0	1.5
ELEC-CI 5 104	Industrial maintenance techniques	3	3	2.25	0
ELEC-CI 5 105	Diagnosis and functional safety .	1.5	2	1.5	0.75
ELEC-CI 5 106	Machine Learning	1.5	3	1.5	0.75
ELEC-CI 5 107	Mod. and Cde des Sys. Mecha	1.5	2	1.5	0.75
ELEC-CI 5 108	Production analysis and management	1.5	2	1.5	0
ELEC-CI 5 109	Renewable Energy and Smart Grids	3	3	1.5	0.75
ELEC-CI 5 110	quality management	1.5	2	1.5	0
	Total	24.00	30		

Biomedical instruments Major: S5

Coded	Subject	Coef	Credit	Course/ week	Practical / week
TV-501	GRH	1.5	2	1.5	0
TV-502	Labor law	1.5	2	1.5	0
TV-503	preparation for certification in Entrepreneurship	1.5	2	1.5	0
EL-IB 5 101	Equipment maintenance 2	3	3	2.25	0
EL-IB 5 102	Medical imaging techniques: CT, ultrasound and MRI	3	3	2.25	0
EL-IB 5 103	Telemedicine and Interoperability: Foundations and Technological Infrastructure	3	3	0.75	1.5
EL-IB 5 104	Automated Systems and Biomedical Equipment Maintenance	3	3	1.5	0.75
EL-IB 5 105	Programming and Integrating Robotic Systems with ROS2	1.5	3	1.5	0.75
EL-IB 5 106	Nuclear Instrumentation and Radiation Applications	1.5	3	1.5	0
EL-IB 5 107	Biomedical Management: Quality, Maintenance and Procurement	1.5	2	1.5	0
EL-IB 5 108	Industry 4.0	1.5	2	1.5	0
EL-IB 5 109	Atomic and Nuclear Physics for Medical Applications	1.5	2	0	1.5
	Total	24	30		

Professional semester S6

Codes	Teachings	Coef	Credit	Course/week	work/week
Pro- 5 2 01	Introductory Traning	10	3	/	/
Pro- 5 2 02	Traning development		3	/	/
Pro- 5 2 03	PFE		24	/	/
		24	**30**	**18**	**6**

Content sheets

COMMON CORE

Course Specification

Electrical Networks

1- General

Coded	ELEC 3 103	Level / Semester	*1/S1*	Coefficient	*2.25*	Credits	*3*
Course	*Electrical engineering*					Volume. H. (CI)	*21h*
Responsible	*Nadia Hajji*					Volume. H. (TP)	*10h30*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*41*
Module	*Electric Networks*					Version	*09/2023*

Course description (Course objective):
Allow the student to acquire basic knowledge of quantities relating to alternating current and three-phase systems as well as alternating / alternating conversion via single-phase and three-phase transformers.

Prerequisites :	*Keywords :*
Basic electrical circuits	*Electrical network, Power, power factor, compensation, electromagnetism*

Specific objectives of the course (OBJ):
OBJ 1 : *Understand the architecture of the electrical network and its elements (transformers, lines, etc.) as well as the vocabulary used (THT, HT, MT, LV).*
OBJ 2 : *Analyze single-phase and three-phase, balanced and unbalanced electrical circuits.*
OBJ 3 : *Analyze the operation of iron-core coils as well as single-phase and three-phase transformers.*

Necessary material :
Single-phase and three-phase alternating network, single-phase and three-phase loads (resistive, inductive and capacitive), measuring devices (voltmeter, ammeter, wattmeter), single-phase and three-phase transformer.

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-3	*Calculation of single-phase powers*	*4:30*	*Understand alternative quantities (voltages, currents, impedances), powers, power factor compensation.*
4-6	*Calculation of three-phase powers*	*4:30*	*Understand alternative quantities (voltages, currents, impedances), power factor compensation.*

7-10	*Transformer single phase*	*6*	*Understand the operation and constitution of an iron core coil, transformer at no load and under load, study of the transformer with the Kapp hypothesis, voltage drop, efficiency.*
11-14	*Transformer three-phase*	*6*	*Study the constitution of a three-phase transformer, the couplings, the hourly index, equivalent diagram and efficiency.*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
1	*Power measurement single-phase*	*1h30*	*- Allow the student to manipulate the wattmeter to measure the active, reactive and apparent powers of an industrial electrical installation in sinusoidal alternating regime.* *- Know how to reduce voltage drops and power losses across power transmission lines, by improving the power factor.*
2	*Measurement of three-phase powers (delta coupling and star coupling)*	*3h*	*- Allow the student to manipulate the wattmeter to measure the active, reactive and apparent powers of an industrial electrical installation in sinusoidal alternating regime.* *- Know how to reduce voltage drops and power losses across power transmission lines, by improving the power factor.*
3	*Transformer study single phase*	*3h*	*-Study the no-load and load operation of a single-phase transformer by measuring its voltage drop and determining its efficiency* *- Empty test* *- Short circuit test* *- Essay in charge.*
4	*Transformer study three-phase*	*3h*	*-Study the no-load and load operation of a three-phase transformer by measuring its voltage drop and determining its efficiency* *- Empty test* *- Short circuit test* *- Essay in charge.*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting

CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	x *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	x *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	x *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes x No*
- *Authorized search engine : ☐ Yes x No*
    - *Criterion 1: Understanding of the content (4 points)*
    - *Criterion 2: Application of knowledge (10 points)*
    - *Criterion 3: Critical analysis (4 points)*
    - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *Bouchard, Réal-Paul and Olivier, Guy, Electrotechnique, editions of the École Polytechnique de Montréal.*
- *Wildi , Théodore, Électrotechnique, third edition, Laval University Press, Quebec.*
- *Alexander, C. K., & Sadiku, M. N. O. (2017). Fundamentals of Electric Circuits (6th ed.). McGraw-Hill Education.*
- *Hayt, W. H., & Kemmerly, J. E. (2013). Engineering Circuit Analysis (8th ed.). McGraw-Hill Education.*

7- Working environment (Facilities necessary for learning)

- *None*

Course Specification

Electrical schematics & Installation

1. General

Coded	ELEC 3 104	Level / Semester	*1/S1*	Coefficient	*3*	Credits	*3*
Course	*Electrical engineering*					Volume. H. (CI)	*21*
Responsible	*Imen KORTAS*					Volume. H. (TP)	*21*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*32*
Module	Electrical schematics & Installation					Version	*09/2023*

Course description (Course objective):
- This course is intended for 3rd year electrical engineering classes ، it presents the study of domestic lighting schemes and neutral regimes.

Prerequisites :	*Keywords :*
Knowledge of some basic notions of domestic electrical equipment.	*Lighting, electrical consumption, architectural diagram, developed diagram, single-line diagram, etc.*

Specific objectives of the course (OBJ):
1. Draw the different electrical diagrams while respecting given specifications. 2. Knowledge and choice of electrical protection devices. 3. Differentiate between neutral regimes.

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-2	Chapter 1: The basic elements of a domestic electrical installation.	*3h*	Know the basic elements of an electrical installation and their roles.
3-4	Chapter 2: Standards and symbols	*3h*	Become familiar with national and international electrical standards

5-6-7-8	Chapter 3: Lighting, power socket and signaling assemblies	*6*	Establish the different lighting schemes.
9-10-11	Chapter 4: LV electrical equipment & personal safety	*4:30*	Choice of electrical equipment according to the type of protection requested.
12-13-14	Chapter 5: neutral regime	*4:30*	Know the neutral regimes and calculate the fault current in each regime.

3- Content elements (Practical work)

Necessary material :
Circuit breaker, switch, push button, socket, lamp, wires, timer, remote control switch,

Week (s)	Activities / Content elements	No. HR	Goals
1	Simple ignition and socket lighting assembly.	*3h*	Control of a lighting circuit from a single location.
2	Dual ignition lighting assembly .	*3h*	Control two lighting circuits from one location.
3	Back and forth assembly	*3h*	*Control of a lighting circuit in two locations*
4	Remote control switch assembly .	*3h*	*Controlling a lighting circuit from several locations*
5	Timer assembly	*3h*	*Control a lighting circuit for a period of time*
6	*Practical exam*	*6*	*Summative evaluation*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	■ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	■ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	■ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes ■ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *Schéma-electrique.net : les circuits électriques : schémas, câblage, branchement*
- *Zoom-elec.com*
- *Herve, J. (2015). Electrical Wiring and Installation (3rd ed.). Wiley-Blackwell.*
- *Norris, J. (2017). The Complete Guide to Electrical Wiring (10th ed.). Craftsman Book Company.*

7- Working environment (Facilities necessary for learning)

- *None*

Course Specification

Linear Systems 1

1. General

Coded	*ELEC 3 105*	Level / Semester	*1/S1*	Coefficient	*3*	Credits	*3*
Course	*Electrical Engineering*					Volume. H. (CI)	*31.5*
Responsible	*Hassani Messoud*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*31*
Module	*Linear Systems1*					Version	*09/2023*

Course description (Course objective):
- Study of continuous linear systems (transfer function, index response, harmonic response, …
- Study of controlled systems (principle, functional diagram, action chain, return chain, etc.)
- Analysis of linear servo systems (Stability, speed, precision)
- Synthesis of controlled systems (PID, phase advance, etc.)

Prerequisites :	*Keywords :*
Electrical circuits, mathematics for engineers	*Laplace transform, differential equations, physical systems*

Specific objectives of the course (OBJ):

OBJ 1 : *Master the concept of physical system*
OBJ 2 : *Understand the basic elements of studying a linear system (Transfer function, answers)*
OBJ 3 : *Study of basic linear systems (1st order system ، generalized 1st order system ، second order system, index response, harmonic response, etc.)*
OBJ 4 : *Explain the concept of controlled systems (feedback, direct chain, feedback chain, open loop transfer function, closed loop transfer function, etc.)*
OBJ 5 : *Concept of stable and unstable system, definition, condition and criteria of stability, degree of stability*
OBJ 6 : *Concept of precision of servo systems (static error, dynamic error), system class, position error, speed error, acceleration error, etc.*
OBJ 7 : *Understanding the correction of a servo system, concept of corrector, PID, etc.*
OBJ 8 : *Understand the concept of sampled systems for digital process control*
OBJ 9 : *Master the mathematical tool Z Transform for the study of sampled systems*

Necessary material :
PC, process

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1	***Chapter 1: Systems linear continuous*** - *Definition* - *Transfer function* - *Examples* - *Responses of a system linear*	*3*	***OBJ 1:*** *Master the concept of system* ***OBJ 2:*** *Understand the basic tools for the study of linear systems.*
1-3	***Chapter 2: Study of systems linear*** - *First order system: time constant, static gain, index response, harmonic response (Bode, Nyquist , Black diagram)* - *Generalized first order system, phase advance and phase delay* - *Study of the second order system, notion of damping and own pulsation, damped system and damped oscillating system* - *Exercises*	*6*	***OBJ 3:*** *Understand the theory of usual linear systems*

3-4	***Chapter 3: Systems enslaved*** - *Concept of systems curly* - *Action chain* - *Return chain* - *Plan functional* - *Open loop transfer function* - *Closed loop transfer function* - *Example systems enslaved* - *Simplification of diagrams functional* - *Exercises*	*6*	***OBJ 4:*** *Understand the concept of controlled systems*
4-5	***Chapter 4 : Systems Stability enslaved*** - *Definition of a stable system* - *Stability condition* - *Stability criteria* • *Routh's criterion* • *Setback Criterion*	*4.5*	***OBJ 5:*** *Understand the notion of stability of a linear system*
	- *Degree of stability* • *Profit margin* • *Phase margin* - *Exercises*		
5-6	***Chapter 5 : Systems Accuracy enslaved*** - *Definition of precision and concept of error* - *Precision static* - *Precision dynamic* - *Position error* - *Speed error* - *Error acceleration* - *Exercises*	*3*	***OBJ 6:*** *Understand the notion of precision as well as the elements affecting this precision, in particular the class of the system*
7-8	***Chapter 6: Fixing Systems enslaved*** - *Concept of correctors* - *Different types of P, PI, PD, PID correctors* - *Approximate forms of correctors: Phase advance, phase delay, etc.* - *Corrector synthesis method* - *Exercises*	*4.5*	***OBJ 7:*** *Master analog correctors and synthesis techniques*

9	***Chapter 7: Systems sampled*** - *Digital process control* • *Plan general of a digital control* • *Study of CNA and CAN* • *Study of sampling (sampling period, Shannon's theorem*	*1h30*	***OBJ 8:*** *Understand the essential hardware part for carrying out a numerical control*
10	***Chapter 8: Transformation in z*** - *Definition* - *Example* - *Properties* - *Transformed in inverse z* - *Solving Equations recurring* - *Exercises*	*3H*	***OBJ 8:*** *Master z transforms as a tool used for modeling sampled systems*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
11	*Simulation of a first order system using the Matlab tool* - *Study of the response index* • *Representation of the response for different time constants.*	*3*	***OBJ 3:*** *Validate the theoretical results*
	• *Determination of response time* • *Determination of rise time* - *Study of the response harmonic* • *Bode diagram* • *Nyquist diagram*		*relating to the study of linear systems*
12	*Simulation of a generalized first order system using the Matlab tool* - *Representation of the index response for different pairs of time constants.* - *Representation of the Bode diagram of a system with phase advance and determination of the maximum phase* - *Representation of the Bode diagram of a phase delay system and determination of the minimum phase*	*3*	***OBJ 3:*** *Validation of theoretical results relating to the study of linear systems*

13-14	*Simulation of a second order system using the Matlab tool* - *Representation of the step response for different values of the damping coefficient.* - *Determination of peak time and overshoot* - *Bode diagram representation* - *Determination of maximum gain and resonance pulsation.*	*4:30*	***OBJ 3:*** *Validation of theoretical results relating to the study of linear systems*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☒ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Criteria devaluation

- *Authorized documents : ☐ Yes ☒ No*
- *Authorized search engine : ☐ Yes ☒ No*
- *Criterion 1: mastery of language (5 points)*

- *Criterion 2: mastery of the development tool (2 points)*
- *Criterion 3: mastery of the architectural aspect (8 points)*
- *Criterion 4: mastery of the methodological and technical aspect (simulation and synthesis) (5 points)*

6- Web references (useful links):

- *Systems and continuous linear control*
- *Systems and discrete linear control*
- *Ogata, K. (2010). Modern Control Engineering (5th ed.). Prentice Hall.*
- *Ziemer, R. E., & Tranter, W. H. (2010). Signals and Systems (4th ed.). Pearson.*

7- Working environment (Facilities necessary for learning)

- *Matlab Software (V2020-2023)*

Course Specification

Signal processing 1

1. General

Coded	ELEC 3 106	Level / Semester	1/S1	Coefficient	3	Credits	3
Course	*Electrical Engineering*					Volume. H. (CI)	*31.5*
Responsible	*Marwa Yousfi*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*31*
Module	*Signal processing 1*					Version	*09/2023*

Course description (Course objective):
The Signal Processing module provides students with an in-depth understanding of the tools and methods needed to analyze and design signal processing systems.

Prerequisites :	*Keywords :*
Mathematics for engineers	*Deterministic signals, Fourier analysis, Spectrum, spectral density, Sampling*

Specific objectives of the course (OBJ):
OBJ 1 : *Introduce the concepts of signals and systems.*
OBJ 2 : *Gain an in-depth understanding of signal processing tools and spectral analysis.*
OBJ 3 : *Master signal acquisition: sampling and quantification.*

Necessary material :
Computers

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-3	***General information on signals and systems :*** *Classification of signals, particular signals, convolution product, impulse response.*	*9*	*Introduce the fundamental concepts of signal processing*
4-5	***Processing of periodic deterministic signals:*** *Fourier series, amplitude spectrum, phase spectrum, power spectral density.*	*7:30*	*Presentation of methods for solving a linear electrical*

			circuit in sinusoidal regime
6-8	***Processing of aperiodic deterministic signals:*** *Fourier transform, Amplitude spectrum, phase spectrum, spectral energy density, Correlation function.*	*9*	*Presentation of the general method for the analysis of reactive circuits*
9-10	***Signal sampling*** *: Sampling and quantification of signals.*	*6*	*Gain an in-depth understanding of filter frequency responses*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
11	***Temporal and frequency study of deterministic signals: Temporal and frequency*** study *of deterministic signals using Matlab.*	*3 H*	*Become familiar with the Matlab environment and its use for representing a signal in the time or frequency domain.*
12	***Spectral analysis of deterministic signals*** *: Use of Matlab for the calculation and representation of the energy or power spectral density and the correlation function.*	*3 H*	*Verification of theoretical results by comparison with the Matlab calculation method.*
13-14	***Sampling of signals*** *: Verification of Shannon's theorem, Sampling and reconstruction.*	*4:30*	*practical demonstration of Shannon's theorem and its importance for the reconstruction of a signal.*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☒*No*	*20%*

DS - Supervised Duty	☒ Yes ☐ No	20%
EE - Written test (Final exam)	☒ Yes ☐ No	60%
EP - Practical test (TP- TP exam / MP- Mini project)	☐ Yes ☒No	

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% CC + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes ☒No*
- *Authorized search engine : ☐ Yes ☒No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *Beginner's guide to digital signal processing*
- *Oppenheim, A. V., & Schafer, R. W. (2009). Discrete-Time Signal Processing (3rd ed.). Pearson.*
- *Proakis, J. G., & Manolakis, D. G. (2013). Digital Signal Processing: Principles, Algorithms, and Applications (4th ed.). Pearson.*

7- Working environment (Facilities necessary for learning)

- *Matlab software*
- *…*

Course Specification

Discrete component electronics

1. General

Coded	ELEC 3 107	Level / Semester	1/S1	Coefficient	1.5	Credits	3
Course	Electrical Engineering					Volume. H. (CI)	21
Responsible	Souha Boukadida					Volume. H. (TP)	10.5
Teaching methods	Lecture, interactive, direct instructions					Self study H.	42
Module	Component Electronics discreet					Version	09/2023

Course description (Course objective):
This course covers the analysis and design of electronic circuits using discrete components. Semiconductor electronic components (diode, bipolar transistor, field effect transistor) are studied and modeled.

Prerequisites :	*Keywords :*
Electronic analog	Diode, bipolar transistor, field effect transistor and MOSFET transistor.

Specific objectives of the course (OBJ):
-Diodes: operating principle, ideal diode, real diode, rectification, filtering, and stabilization. -Bipolar transistors: operating principle, static regime, switching operation, current sources, amplifier operation. -JFET transistor: Different types and electrical characteristics. -MOSFET transistor: Different types and electrical characteristics.

Necessary material :
GBF, test plate, diode, transistor, stabilized power supply and oscilloscope.

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-4	*The diodes*	*6H*	Know the operating principle of an ideal diode and a real diode. Simple half-wave rectification , filtering , and stabilization .
5-8	*Bipolar transistors*	*6H*	Bipolar transistor: -In the static regime (polarization and static characteristics).

			-In the dynamic regime (electrical characteristics of the amplifier in alternating operation).
9-12	*JFET and* MOSFET transistor	*6H*	Different types and electrical characteristics.
13-14	Tests and applications	*3h*	Assessment of acquired skills

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
8-9	Rectification, filtering and stabilization by Zener diodes.	3h	The student must master the different assemblies: - rectification (flow on a resistive load, on an RC load and on an RL load). - Zener diode stabilization .
10-11	Bipolar transistor bias	3h	- Bipolar transistor: polarization and tracing of the different static characteristics.
12-14	Bipolar transistor amplifier: common emitter, common collector, common base.	4:30	Bipolar transistor in the dynamic regime: Electrical characteristics of the amplifier in alternating operation.

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☑ *Yes* ☐ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☒ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes ☒ No*
- *Authorized search engine : ☐ Yes ☒ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *Discrete Component - an overview*
- *Discrete components – characteristics and examples*
- *Horowitz, P., & Hill, W. (2015). The Art of Electronics (3rd ed.). Cambridge University Press.*
- *Sedra, A. S., & Smith, K. C. (2015). Microelectronic Circuits (7th ed.). Oxford University Press.*

7- Working environment (Facilities necessary for learning)

- *Electronic Lab*
- *...*

Course Specification

Functions for Digital Electronics

1. General

Coded	*ELEC 3 108*	Level / Semester	*1/S1*	Coefficient	*1.5*	Credits	*3*
Course	*Electrical engineering*					Volume. H. (CI)	*21*
Responsible	*Wafa Boukadida*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*42*
Module	Functions for Digital Electronics					Version	*09/2023*

Course description (Course objective):
The objective of this course is to provide additional knowledge on the concepts of systems logic and the various integrated components of digital electronics. A first part is devoted to the study of the different integrated circuits of combinatorial logic. This being done, the sequential logic will be discussed.

Prerequisites :	*Keywords :*
Electronic analog	Combinational Logic

Specific objectives of the course (OBJ):
- OBJ 1: Understand the principle of combinatorial logic and sequential logic - OBJ 2: Understand the operating principle of basic circuits of combinational logic as arithmetic circuits, switching circuits etc. - OBJ 3: Understand the principle of operation of basic circuits of sequential logic like scales, counters

Necessary material :
Models of combinatorial logic, models of sequential logic.

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-4	*Combinational logic circuits*	*6*	*Understand the principle of operation of encoders, decoders, arithmetic circuits*
5-9	*Switching circuits*	*3*	Understand the principle of operation of multiplexers and demultiplexers
10-14	*Introduction to sequential logic*	*4.5*	Understand the principle of sequential logic
	Counters	*9*	Design synchronous and asynchronous counters and down counters

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
8-9	*Combinational logic circuits*	3	Understand the operating principle of the different circuits of combinatorial logic
10-11	*The seesaws*	3	Study of different flip-flops RS, D, JK
12-14	*Counters and down counters*	4.5	Design synchronous and asynchronous counters and decounters

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☒ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes ☒ No*
- *Authorized search engine : ☐ Yes ☒ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *Digital electronics*
- Lecture Notes for Digital Electronics
- Morris Mano, M. (2017). Digital Design (6th ed.). Pearson.
- Thomas L. Floyd, J. (2018). Digital Fundamentals (11th ed.). Pearson.

7- Working environment (Facilities necessary for learning)

Working lab, simulators

Course Specification

Electrical circuits

1. General

Coded	*ELEC 3 109*	Level / Semester	*1/S1*	Coefficient	*2.25*	Credits	*3*
Course	*Electrical engineering*					Volume. H. (CI)	*21*
Responsible	*Marwa Yousfi*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*40*
Module	*Electrical circuits*					Version	*09/2023*

Course description (Course objective):
The general objective of this module is to present the basic notions of electronics, the fundamental methods of calculating direct current and alternating current electrical circuits.

Prerequisites :	*Keywords :*
Fundamentals of electricity, basic mathematics	*Continuous speed, Variable speed, transient speed, filters*

Specific objectives of the course (OBJ):
OBJ 1 : *Become familiar with the tools necessary to solve a linear electrical circuit in continuous mode.* ***OBJ 2 :*** *Presentation of the methods allowing the resolution of a linear electrical circuit in variable regime.* ***OBJ 3 :*** *Presentation of the general method for the analysis and resolution of reactive circuits.* ***OBJ 4 :*** *Gain an in-depth understanding of filter frequency responses.*

Necessary material :
Test plates, resistors, capacitors, chokes, stabilized power supplies, measuring devices, low frequency generators, oscilloscopes

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-3	***Linear electric circuits in continuous mode*** *: Definitions, Ohm's and Kirchhoff's law, fundamental theorems (association of dipoles, superposition theorem, Thévenin's*	*4.5H*	*Introduce the laws which make it possible to solve a linear electrical*

	theorem, Norton's theorem, Millmann's theorem , Kennely 's theorem).		*circuit in continuous mode*
4-6	***Linear electrical circuits in variable regime:** characteristics of a sinusoidal signal, its Cartesian, Fresnel and complex representation, passive dipoles in sinusoidal regime, powers in sinusoidal regime.*	*4.5H*	*Presentation of methods for solving a linear electrical circuit in sinusoidal regime*
7-10	***Linear electrical circuits in transient regime:** Definitions, equation of transient regimes, Answers of first order circuits (Charging/Discharge of a capacitor through a resistor, establishment and breaking of current in a choke through a resistor), Answers second order circuits (Charging/Discharging a capacitor through a resistor and a choke, etc.)*	*6*	*Presentation of the general method for the analysis of reactive circuits*
11-14	***Passive filters** : Definitions, Determination of the nature of a filter through an asymptotic study. Calculation of the transmittance of a filter. Determination of the characteristics of a filter. Diagram representation Bode asymptotic .*	*6*	*Gain an in-depth understanding of filter frequency responses*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
1	***Verification of direct current laws:** Thévenin's theorem, Norton's theorem and superposition theorem*	*3 H*	*Manipulation of electrical circuits in continuous operation*
2	***Transient regimes** : Visualization of electrical signals using the oscilloscope. Study of RC, RL and RLC circuits and verification of experimental results with theory. Experimental determination of the characteristic time constant of the circuit using an acquisition with the oscilloscope.*	*3 H*	*Experimental determination of the response characteristics of a circuit in transient conditions*
3	***Study of passive filters** : Low-pass filter, high-pass filter and band-pass filter*	*4:30*	*experimental demonstration of the behavior of filters towards input signals of various frequencies.*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☒ *Yes* ☐ *No*	*20%*
DS - Supervised Duty	☒ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☒*No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents* : ☐ *Yes* ☒*No*
- *Authorized search engine* : ☐ *Yes* ☒*No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- Electric Circuits - Physics Tutorial
- Electric Circuits | Overview, Types & Component
- Alexander, C. K., & Sadiku, M. N. O. (2017). Fundamentals of Electric Circuits (6th ed.). McGraw-Hill Education.
- Nilsson, J. W., & Riedel, S. A. (2015). Electric Circuits (10th ed.). Pearson.

7- Working environment (Facilities necessary for learning)

- *simulators*
- *...*

Course Specification

Computer architecture

1. General

Coded	*ELEC 3 110*	Level / Semester	*1/S1*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical engineering*					Volume. H. (CI)	*21*
Responsible	*Souha Boukadia*					Volume. H. (TP)	*0*
Teaching methods	interactive, direct instructions,Project Based					Self study H.	*28*
Module	*Computer architecture*					Version	*09/2023*

Course description (Course objective):
The objective of the course is to clearly explain the operating principle of the computer with a detailed presentation of its architecture .

Prerequisites :	*Keywords :*
digital electronics	*Coding; decoding; architecture of floating point computers.*

Specific objectives of the course (OBJ):
The main points covered in this course are: *Introduction to the concept of computer architecture.* *The main components of a computer.* *Concepts on computer instructions.*

Necessary material :

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-4	*Main computer components*	*6H*	- *Describe the fundamental elements of a computer and how they work.* - *Present the main modules constituting the architecture of a computer .* - *Explain the functionality of each of these modules and their functional relationships in the computer .*
5-9	*Basics of computer instructions*	*7:30*	- *Describe the components of a machine instruction and how the instructions are executed.* - *Describe programming languages (High level, assembler and machine), the principle of compilation and assembly.*
10-14	Processor	*7:30*	- *Processor* - *Microprocessor* - *External structure of the processor* - *Internal structure of the processor*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
			-

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes ☒ No*
- *Authorized search engine : ☐ Yes ☒ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*
- *)*

6- Web references (useful links):

Computer Architecture: Components, Types, Examples

Computer Architecture Course (Princeton)

Computer Architecture Tutorial
Hennessy, J. L., & Patterson, D. A. (2019). *Computer Architecture: A Quantitative Approach (6th ed.). Morgan Kaufmann.*
Stallings, W. (2018). *Computer Organization and Architecture: Designing for Performance (10th ed.). Pearson.*

7- Working environment (Facilities necessary for learning)

- *None*
- *...*

Course Specification

Mathematics

1.General

Coded	*ELEC 3 111*	Level/Semester	*1/S1*	Coefficient	*3*	Credits	*3*
Course	*Electrical engineering*					Volume. H. (CI)	*21h*
Responsible	*Zied Garbouj*					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*46*
Module	Mathematics for engineers					Version	*09/2023*

Course description (Course objective):
This course allows students to gain advanced knowledge of mathematics and develop skills to solve engineering problems using mathematical techniques.

Prerequisites:	*Keywords :*
L1 and L2 mathematics courses *Mathematical tools at a BAC+2 level*	-Functions with a real variable (limit and continuity). - Derivation and primitive. - Integral calculation. -Differential equations.

Specific objectives of the course (OBJ):
At the end of this course, students will: **OBJ 1:** Be able to calculate Fourier transforms of non-periodic functions. **OBJ 2:** Understand the notion of the convolution product. **OBJ 3:** Understand the concepts of Laplace transforms and inverse Laplace transforms. Be able to solve a differential equation using Laplace transforms. **OBJ 4:** Know how to decompose a periodic signal into a Fourier sum.

Necessary material :

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	Chapter 1: Laplace Transformation - General - Properties - Convolution	3h	Introduction to the Laplace transform and its use to solve linear Ordinary Differential Equations (ODE) of order n
3-4	-Practical methods for calculating the image and an original -Application: Use the Laplace transform to solve a differential equation	3h	
5-6	TD-Series 1	*3h*	
7-8	Chapter 2: Fourier Transformation -General -Terms	*3h*	In this chapter, to simplify, we will introduce the notion of Fourier transform on R rather than on R^d. This short chapter is an interesting application of the previous integration course, in the sense that many results are used (dominated convergence theorem, continuity and differentiability theorems for parameter integrals, convolution product, density of step functions in L 1 ...).
9-10	-Properties -Convolution	*3h*	
11-12	- Inversion - Plancherel and Parseva formulas TD=Series 2	*3h*	
13-14	Detailed series of exercises throughout the course	*3h*	Evaluate the overall level of students and rectify gaps

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ■ *No*	
DS - Supervised Duty	■ *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	■ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ■ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes ■ No*
- *Authorized search engine : ☐ Yes x No*
- *Criterion 1: Understanding of the content (4 points)*
- *Criterion 2: Application of knowledge (10 points)*
- *Criterion 3: Critical analysis (4 points)*
- *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- Mathematics for engineers. Authors: Yves Leroyer and Patrice Tesson - Edition Dunod
- **Stewart, J. (2015).** *Calculus: Early Transcendentals* (8th ed.). Cengage Learning.
- **Anton, H., & Rorres, C. (2013).** *Elementary Linear Algebra* (11th ed.). Wiley.

7- Working environment (Facilities necessary for learning)

Course Specification

Direct current machines

1- Généralités

Coded	*ELEC 3 203*	Level / Semester	*1/S2*	Coefficient	*3*	Credits	*3*
Course	*Electrical engineering*					Volume. H. (Cl)	*21h*
Responsible	*Nadia Hajji*					Volume. H. (TP)	*10,30*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*40*
Module	Direct current machines					Version	*09/2023*

Course description (Course objective):
Allow the student to know direct current electrical machines: the constitution, the operating principle, the operation as a generator and the operation as a motor.

Prerequisites :	*Keywords :*
Electric circuits , Electromagnetism	...

Specific objectives of the course (OBJ):
OBJ 1 : *Study the operation of the direct current generator*
OBJ 2 : *Study the operation of the DC motor*

Necessary material :
Direct current machines, direct voltage generators, rheostat, measuring devices, dynamo-tachometer...

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-3	*DC generator operation*	*4:30*	*Understanding the e.m.f. induced, voltage equations, torques, various excitation modes (separate, parallel, series, compound), armature magnetic reaction (compensation poles), switching (switching aid poles), characteristics.*
4-6	*Study of the Shunt excitation generator*	*4:30*	*Study the different characteristics: no-load and priming characteristic (operating point), load characteristic and adjustment characteristic.*

7-10	*Study of the DC motor with Shunt/separate excitation*	*6am*	*Study the characteristics, predetermination of the characteristics, modification of the characteristics, starting, braking).*
11-14	*Study of the DC motor with series/compound excitation*	*6am*	*characteristics, predetermination of characteristics, modification of characteristics, starting, braking).*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
1-2	*Study of the independently excited generator.*	*3H*	- *See the morphology of the machine* - *Study the role of the collector* - *Study the Magnetic Armature Reaction (RMI)* - *Determine the no-load characteristics (magnetization curve)* - *Determine the load characteristics*
3-4	*Study of the Shunt excitation generator*	*3H*	*-Construction of PICOU.* *-Directly note the load curve U(I) and compare it to that deduced by the construction of Picou .*
5-6	*Study of the compound excitation motor and the series excitation motor.*	*3H*	- *Determine the speed as a function of the induced current: theoretical and experimental.* - *Determine the speed according to the useful torque: theoretical and experimental.* - *Determine the useful power according to the induced current.* - *Determine the efficiency as a function of the induced current).*
7	*Practical exam, mini-project defense, …*	*1h30*	*Summative evaluation*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	x *Yes* ☐ *No*	*20%*

EE - Written test (Final exam)	x *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	x *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Criteria devaluation

- *Authorized documents : ☐ Yes x No*
- *Authorized search engine : ☐ Yes x No*
    - *Criterion 1: Understanding of the content (4 points)*
    - *Criterion 2: Application of knowledge (10 points)*
    - *Criterion 3: Critical analysis (4 points)*
    - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *Luc Lasne , Electrical energy: Electrotechnics - Magnetism - Machines – Networks, Edition Dunod, 04/04/2018…*
- *Michel Lambert, Electric transformers: Operation, implementation and operation, Edition Dunod, 03/30/2016.*
- *Guy Séguier, Francis Notelet , Industrial electrical engineering, Edition Lavoisier, 3rd edition , 02/21/S2006.*

7- Working environment (Facilities necessary for learning)

- *None*
- *…*

Course Specification

Electrical Installation LAB

1. General

Coded	*ELEC 3 204*	Level / Semester	*1/S2*	Coefficient	*1.5*	Credits	*3*
Course	*Electrical engineering*					Volume. H. (CI)	
Responsible	*Imen Kortas*					Volume. H. (TP)	*21*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*50*
Module	*Electrical Installation LAB*					Version	*09/2023*

Course description (Course objective):
- 3rd year electrical engineering classes , it presents the sizing of electrical devices, the starting processes of asynchronous motors and braking methods.

Prerequisites :	*Keywords :*
Knowledge of some basic notions of industrial electrical equipment.	*Three-phase motor, single-line diagram, starting, protective devices*

Specific objectives of the course (OBJ):
4. Study and creation of starting diagrams for asynchronous motors. 5. Sizing and choice of electrical protection devices. 6. Studies of braking processes for asynchronous motors.

2- Content elements (Practical work)

Necessary material :
Circuit breaker, contactor, push button, thermal relay, conductor wires, asynchronous motor.

Week (s)	Activities / Content elements	No. HR	Goals
1 -2	TP1: Direct starting of a three-phase asynchronous motor in only one direction of rotation	*3h*	The student must be able to install a direct start in 1 direction of rotation of an electric motor.
3-4	TP2: Direct starting of a three-phase asynchronous motor in two directions of rotation.	*3h*	The student must be able to install a direct start in 2 directions of rotation of an electric motor.

5-6	TP3: Semi-automatic direct start in two directions of travel with limit stop	*3h*	*The student must be able to install a direct start in 2 directions of rotation with end stops.*
7-9	TP4: starting by eliminating stator resistances	*4:30*	*The student must be able to install a motor start by action on the stator.*
10-12	TP5: starting by eliminating stator resistances	*4:30*	*The student must be able to install a motor start by action on the rotor.*
13-14	*Practical exam*	*3h*	*Summative evaluation*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	x *Yes* ☐ *No*	
DS - Supervised Duty	☐ *Yes i* ☐ *No*	
EE - Written test (Final exam)	☐ *Yes* ☐ *No*	
EP - Practical test (TP- TP exam / MP- Mini project)	x *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes* [redacted]*No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Electrical Installation Guide Electrical
Installation - an overview Electrical
wiring
Basics of Electrical Installation Work
Herve, J. (2015). Electrical Wiring and Installation (3rd ed.). Wiley-Blackwell.
Norris, J. (2017). The Complete Guide to Electrical Wiring (10th ed.). Craftsman Book Company

7- Working environment (Facilities necessary for learning)

- *None*

Course Specification

Linear Systems 2

1. General

Coded	*ELEC 3 205*	Level / Semester	*1/S2*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*Hassani messoud*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*18.5*
Module	*Systems Linear 2*					Version	*09/2023*

Course description (Course objective):
- Study of continuous linear systems (transfer function, index response, harmonic response, …
- Study of controlled systems (principle, functional diagram, action chain, return chain, etc.)
- Analysis of linear servo systems (Stability, speed, precision)
- Synthesis of controlled systems (PID, phase advance, etc.)

Prerequisites :	*Keywords :*
Electrical circuits, mathematics for engineers	*Laplace transform, differential equations, physical systems*

Specific objectives of the course (OBJ):
OBJ 1 : *Master the modeling of sampled systems, sampled transfer function*
OBJ 2 : *Systems sampled enslaved*
OBJ 3 : *Stability of sampled systems, definition, condition and stability criteria*
OBJ 4 : *Accuracy of sampled servo systems (static error, dynamic error), system class, position error, speed error, acceleration error, etc.*
OBJ 5 : *Understanding the correction of a sampled servo system, concept of corrector, PID, Synthesis of digital correctors.*

Necessary material :
PC, process

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals

1 -3	***Chapter 1: Sampled transmittances*** - *Definition* - *Effect of sampler position* - *Answer index* - *Exercises*	*4:30*	***OBJ 1:*** *Master the modeling of sampled systems*
4-6	***Chapter 2 : Systems stability sampled*** - *Definition* - *Stability condition* - *Stability criteria* • *Routh's criterion* • *Jury Criterion* - *Exercises*	*4:30*	***OBJ 3:*** *Understand the notion of stability and the stability conditions of sampled systems*
7-10	***Chapter 3: Accuracy of servo systems*** - *Definition of precision and concept of error* - *Precision static* - *Precision dynamic* - *Position error* - *Speed error* - *Error acceleration* - *Exercises*	*6am*	***OBJ 4:*** *Understand the notion of precision as well as the elements affecting this precision, in particular the class of the system*
11-14	***Chapter 4: Fixing Systems enslaved*** - *Concept of correctors digital* - *Concept of control laws* - *Implementation of control laws* - *Summary of digital PID correctors* - *Exercises*	*6am*	

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
8-9	*System simulation of a sampled system on Matlab* - *Solving equations recurring* - *Answer index*	*3*	***OBJ 3:*** *Use z-transforms to solve recurring equations*
10-11	- *Fixing systems sampled* - *Summary of PI, PID correctors* - *Implementation of the control law*	*3*	***OBJ 3:*** *Validation of theoretical results relating to the study of linear systems*

12-14	- *Simulation of different types of digital correctors*	*4:30*	***OBJ 3:*** *Validation of theoretical results relating to the study of linear systems*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☒ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Criteria devaluation

- *Authorized documents* : ☐ *Yes* ☒ *No*
- *Authorized search engine* : ☐ *Yes* ☒ *No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *Systems and continuous linear control*
- *Systems and discrete linear control*
- *Ogata, K. (2010). Modern Control Engineering (5th ed.). Prentice Hall.*
- *Basile, M., & Tiberi, M. (2019). Linear Systems Theory (2nd ed.). Springer.*

7- Working environment (Facilities necessary for learning)

- *Software Matlab*

Course Specification

Signal processing 2

1. General

Coded	*ELE 3,206*	Level / Semester	*1/S2*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*Marwa Yousfi*					Volume. H. (TP)	*10:30*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*16*
Module	*Signal processing 2*					Version	*09/2023*

Course description (Course objective):
Signal Processing Module 2 provides students with an opportunity to gain an in-depth understanding of essential digital signal processing tools and methods, such as Discrete-Time Fourier Transform (TFTD), Discrete Fourier Transform (DFT) , the Z Transform. This course also allows you to learn the methods of synthesizing digital filters.

Prerequisites :	*Keywords :*
Mathematics for engineers	*TFTD, TFD, Z-transform, Digital filtering*

Specific objectives of the course (OBJ):
OBJ 1 : *Presentation of the general method of frequency analysis of discrete signals.*
OBJ 2 : *Master digital filter synthesis tools.*

Necessary material :
Computers

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-4	***Frequency analysis of linear and discrete invariant systems (SLID):*** *Definitions, Temporal analysis of discrete signals, Discrete-time Fourier transform, TFD of signals of unlimited length.*	*6*	*Become familiar with discrete signal processing tools*
5-9	***Analysis of digital filters using the Z transform (TZ):*** *Definitions, Z transforms, Properties of the TZ, rational TZ, Determination of the impulse response of digital filters.*	*7:30*	*Use the Z Transform for the representation and*

			analysis of digital filters.
10-14	***Synthesis of digital filters:*** *Synthesis of FIR filters by the window method, Synthesis of FIR filters by the frequency sampling method, Synthesis of RII filters by the impulse response method, Synthesis of RII filters by the transformation method bilinear*	*7:30*	*Study of the different methods of synthesizing digital filters, namely RII and RIF filters*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
1	***Analysis of Digital Filters in MATLAB:*** *Introduction of a digital filter, Calculation and representation of the impulse and frequency responses of a filter.*	*3 H*	*Use Matlab to display the temporal and frequency representation of the response of a digital filter.*
2	***Synthesis of RII digital filters:*** *Synthesis of an RII filter using an indirect approach, Synthesis of an RII filter using a direct approach, Use of a Matlab graphical tool which allows the design of an RII filter.*	*3 H*	*Become familiar with the practical aspect of synthesizing a digital IIR filter using Matlab tools*
3	***Synthesis of RIF digital filters:*** *Synthesis of RIF Digital Filters by the window method, Synthesis of RIF Digital Filters by optimization methods, Comparison of RII and RIF filters*	*4:30*	*Become familiar with the practical aspect of synthesizing a digital FIR filter using Matlab tools*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☒*No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*20%*

EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☒*No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- 100% CI material : Average = 40% DS + 60% EE
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Criteria devaluation

- *Authorized documents : ☐ Yes ☒No*
- *Authorized search engine : ☐ Yes ☒No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *Digital Signal Processing*
- *Oppenheim, A. V., & Schafer, R. W. (2010). Discrete-Time Signal Processing (2nd ed.). Pearson.*
- *Proakis, J. G., & Manolakis, D. G. (2007). Digital Signal Processing: Principles, Algorithms, and Applications (4th ed.). Pearson.*

7- Working environment (Facilities necessary for learning)

- *None*
- *…*

Course Specification

Electronic Functions & Systems

1. General

Coded	*ELEC 3 207*	Level / Semester	*1/S2*	Coefficient	*3*	Credits	*3*
Course	*Electrical engineering*					Volume. H. (CI)	*21*
Responsible	*Wafa Boukadida*					Volume. H. (TP)	*10:30*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*40*
Module	Functions & Systems electronic					Version	*09/2023*

Course description (Course objective):
This course will essentially deal with the operation of a differential pair in order to approach the study of real operational amplifiers. It will also cover the different types of active filters and the different oscillator structures.

Prerequisites :	*Keywords :*
Electronic analog 1	operational amplifier ; differential amplifier; active filters and oscillators.

Specific objectives of the course (OBJ):
The objectives of this course are: - Deal with the operation of a differential pair in order to approach the study of real operational amplifiers as well as the internal structure of an operational amplifier in order to construct the real model of an operational amplifier. - Treat the different types of active filters (Rauch and Sallen Key structure). - And analyze the main types of oscillators (Wien Bridge Oscillators, Phase Shifting Oscillator and Colpitts Oscillator).

Necessary material :
GBF, test plate, diode, amplifier, resistors, stabilized power supply and oscilloscope.

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-4	*Amplifiers operational*	*6H*	Describe the real characteristics and parameters, dynamic behavior, the ideal model and the real model, the principle of counter-reaction, as well as the fundamental

			arrangements in linear and non-linear regimes.
5-9	*Filters assets*	*7:30*	Treat the different types of active filters (Rauch and Sallen Key structure).
10-14	*Oscillators*	*7:30*	Analyze the main types of oscillators (Wien bridge oscillators, phase-shifting oscillators and Colpitts oscillators).

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
7-9	*Amplifiers operational*	3h	The student must master the different assemblies: -fundamental assemblies based on operational amplifiers; -and the amplifier differential .
9-11	*Filters assets*	3h	Treat the different types of active filters (Rauch and Sallen Key structure).
11-13	*Oscillators*	3h	Deal with the main types of oscillators (Wien Bridge Oscillators, Phase Shifting Oscillator and Colpitts Oscillator).
14	*assessment*	1h30	Summary assessment

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☒ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Criteria devaluation

- *Authorized documents : ☐ Yes ☒ No*
- *Authorized search engine : ☐ Yes ☒ No*
    - *Criterion 1: Understanding of the content (4 points)*
    - *Criterion 2: Application of knowledge (10 points)*
    - *Criterion 3: Critical analysis (4 points)*
    - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- ***Lecture Notes for Analog Electronics***
- ***ANALOG ELECTRONICS AND OPAMP***
- ***Boylestad, R. L., & Nashelsky, L. (2009). Electronic Devices and Circuit Theory (10th ed.). Pearson.***
- ***Smith, J. G. (2013). Electronic Circuits: Handbook of Design and Applications. McGraw-Hill Education.***

7- Working environment (Facilities necessary for learning)

- *None*
- *…*

Course Specification

Object Oriented Programming

1. General

Coded	ELEC 3 208	Level / Semester	1/S2	Coefficient	3	Credits	3
Course	Electrical Engineering					Volume. H. (CI)	0
Responsible	Montasar BEN SAAD					Volume. H. (TP)	21
Teaching methods	interactive, direct instructions, Project Based					Self study H.	51
Module	Programming Oriented Object					Version	09/2023

Course description (Course objective):
The Object Oriented Programming (OOP) for C++ and Java course offers an in-depth exploration of the fundamentals and advanced principles of OOP. Focused on C++ and Java languages, it teaches the creation of classes, objects and the manipulation of key concepts such as encapsulation, inheritance and polymorphism. Students learn to manage memory efficiently (dynamic allocation, garbage collection), to use advanced features specific to each language (templates , exceptions for C++, Java virtual machine for Java) and to solve concrete problems through practical projects . The goal is to train developers who can design robust applications, solve problems in an object-oriented manner, and produce clean, efficient code, while understanding the key differences between these two languages.

Prerequisites :	Keywords :
• Basic programming knowledge: Understanding of basic programming concepts, such as variables, loops, control structures, functions/methods, and data types. • Familiarity with memory concepts: Basic knowledge of memory management (allocation, freeing) would be beneficial, especially for C++. • Understanding of algorithms and programming logic: Know how to solve simple problems using basic algorithms and data structures. • Computer Systems Basics: Understand how a computer works, the role of a compiler/interpreter, and how programs run on a machine.	OOP, Classes, Objects, Encapsulation, Inheritance, Polymorphism, C++, Java, Memory, Templates (for C++), Exceptions, JVM (Java Virtual Machine), Garbage collection, Algorithms, Data structures, Object-oriented development, Problem-solving, Efficient Code, Best Practices

Specific course objectives (OBJ):
OBJ 1 : Master the fundamental concepts of OOP: Deeply understand the concepts of encapsulation, inheritance, polymorphism and abstraction to design effective class structures.
OBJ 2 : Apply the principles of OOP in C++ and Java: Know how to implement object-oriented concepts in both languages, using the features specific to each language to create robust applications.

OBJ 3 : Effectively manage memory and exceptions: Acquire the skills to manage memory in C++ (dynamic allocation, freeing) and understand automatic memory management via the garbage collector in Java. In addition, know how to handle exceptions for better error management.

OBJ 4 : Develop object-oriented problem-solving skills: Be able to analyze, design and solve real-world problems using object-oriented approaches, while producing clear, efficient and well-structured code in both languages.

Necessary material :

- A computer with a Java/C++ development environment such as IntelliJ IDEA, Eclipse or NetBeans.
- Internet access for additional resources, Java/C++ documentation and updates.

2- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
01	**Introduction to OOP and Basic Concepts**	1h30	Understanding of fundamental OOP concepts
02	**Classes and objects in C++ and Java**	1h30	Application of the concepts of classes and objects in both languages
03	**Encapsulation and abstraction**	1h30	Mastery of encapsulation and abstraction for clear interfaces
04	**Inheritance and polymorphism**	1h30	Understanding inheritance and polymorphism for relationships between classes
05	**Memory management in C++**	1h30	Learning memory management in C++ (allocation, release)
06	**Features advances in C++**	1h30	Exploration of advanced features (templates , exceptions) in C++
07	**Using C++ standard libraries**	1h30	Practical with standard libraries in C++
08	**Practical projects in C++**	1h30	Application of knowledge in practical C++ projects
09	**Memory management in Java**	1h30	Understanding Garbage Collector for Automatic Handling in Java
10	**Features advances in Java**	1h30	Specific use of Java (JVM, advanced exceptions)
11	**Exception Handling in Java**	1h30	Mastery of exception handling for better error handling
12	**Object-oriented problem solving**	1h30	Development of skills to solve concrete object-oriented problems

13	**Practical projects in Java**	1h30	Application of the concepts studied in practical projects in Java
14	**Practical and summary exam**	1h30	Skills Assessment acquired

3- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☑ Yes ☐ No	
DS - Duty to Monitor	☐ Yes ☑ No	40%
EE - Written test (Final exam)	☐ Yes ☑ No	60%
EP - Practical test (TP- TP exam / MP- Mini project)	☑ Yes ☐ No	

- Material 100% TP : Average = 20% CC + 80% EP
- 100% CI material : Average = 40% DS + 60% EE
- CI+TP material : Average = 20% DS + 20% EP + 60% EE

4- Criteria devaluation

- Authorized documents : ☐ Yes ☑ No
- Authorized search engine : ☐ Yes ☑ No

5- Web references (useful links):

- Oracle Java Documentation: https://docs.oracle.com/javase/ - The official Java documentation provided by Oracle, containing tutorials, guides and references for Java SE.
- cplusplus.com: http://www.cplusplus.com/ - A site offering tutorials, references and documentation for the C++ programming language.

6- Working environment (Facilities necessary for learning)

- Software and Tools: Access to integrated development environments (IDE) such as IntelliJ IDEA, Eclipse or NetBeans for programming in Java/C++.
- Libraries and Frameworks : Where applicable, access to specific libraries or frameworks used in the course

Course Specification

Microprocessor and microcontroller engineering

1. General

Coded	*ELEC 3 209*	Level / Semester	*1/S2*	Coefficient	*3*	Credits	*3*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*Abdessalem BEN ABD ELALI*					Volume. H. (TP)	*21*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*31*
Module	Microprocessor and microcontroller engineering					Version	*09/2023*

Course description (Course objective):
- *Understand the internal architecture and operating principle of a microprocessor* - *Understand the mechanics of assembly programming* - *Study, through a typical example of a microprocessor, of advanced architectural techniques and the implementation in the microprocessor hardware of different programming aspects*

Prerequisites :	*Keywords :*
Digital electronics (combinatorial and sequential circuits)	*Microprocessor , assembler , architecture, programming*

Specific objectives of the course (OBJ):
OBJ 1 : *Master the digital components constituting a microprocessor* ***OBJ 2 :*** *Understand the basic elements of microprocessors and their operation: Instruction set, Opcode, Instruction register (IR), Program counter (PC), Instruction cycle, control word, etc.* ***OBJ 3 :*** *Be able to derive the data path and control unit circuit for a given instruction set and analyze the complete microprocessor circuit* ***OBJ 4 :*** *Be able to write programs in assembly and machine language using the instruction set of a given processor* ***OBJ 5 :*** *Be able to analyze the architecture and operation of a microprocessor system - microcontroller* ***OBJ 6 :*** *Understand advanced microprocessor architectural techniques through the study of the microarchitecture of a typical (32-bit) microprocessor: the MIPS processor.* ***OBJ 7 :*** *Understand the implementation in the microprocessor hardware of different aspects of programming: manipulation of arrays and character strings, pointers, definition and call of functions, stack manipulation, etc.*

OBJ 8 : *Understand the software development chain: how to translate a program from high-level language to machine language, map the program and data into system memory, and begin executing the program.* ***OBJ 9 :*** *Learn how to handle microcontroller cards and programming*

Necessary material :
PC, cards microcontroller

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-2	***Chapter 1: Introduction*** ***Chapter 2: Reminder of typical digital components of a microprocessor:*** - *UAL* - *Status indicators (flags)* - *Records* - *Files register* - *Memory* - *…*	*3* *(2x1.5)*	***OBJ 1***
3-6	***Chapter 3: Study of the basics of operation and structure of a processor*** *- Basic elements: instruction sets, assembly language, machine language, etc.* *- Section I: Study of a first example of a basic processor with a single instruction memory* *- Section II: Study of a second example of a basic processor with instruction and data memory*	*6* *(4x1.5)*	***OBJ 2, OBJ 3, OBJ 4***
7-10	***Chapter 4: MIPS Processor Architecture*** ▪ *MIPS instruction sets* ▪ *Hardware architecture (Microarchitecture) of the MIPS processor* ○ *Unicycle* ○ *Multi-cycle* ▪ *MIPS processor pipeline architecture and data and control hazards*	*6* *(4x1.5)*	***OBJ 6, OBJ 7***
11-14	***Chapter 4: Programming the MIPS Processor***	*6*	***OBJ 7***

	▪ *mips Instructions: Registers, Memory and Constants* ▪ *Machine language* ▪ *Programming mips* o *Arithmetic / Logic Instructions* o *Generation of Constants* o *Connection conditional and unconditional* o *If / Else* o *Switch/Box* o *While Loops* o *For Loops* o *The tables* o *Character strings* o *The procedures* o *The battery* ▪ *Addressing modes* ▪ *Mapping Memory* ▪ *Software development chain: from Code c to program execution* o *From C to assembler (compilation)* o *From assembler to machine code (assembly)* o *Mapping machine code into memory and linking to the operating system*	*(4x1.5)*	***OBJ 8***

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
7	*Familiarization with microcontrollers and development tools*	*3* *(1x3)*	***OBJ 5:*** ***OBJ 9***
8	*Development of a microcontroller-based card application*	*3* *(1x3)*	***OBJ 5*** ***OBJ 9***
9	*Familiarization with a MIPS emulator and study of the structure of an assembly program*	*3* *(1x3)*	***OBJ 4***
10-11	*Practice of different applications of MIPS instructions*	*6* *(2x3)*	***OBJ 4***
11	*Practice different applications of MIPS instructions using functions and procedures*	*6* *(2x3)*	***OBJ 4***
12	*Practical exam, mini-project defense, …*	*1.5*	*Summative evaluation*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☒ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Criteria devaluation

- *Authorized documents : ☐ Yes ☒ No*
- *Authorized search engine : ☐ Yes ☒ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *https://mips.com/, 2023*
- *https://pages.cs.wisc.edu/~larus/spim.html , 2023*
- *See MIPS run by Dominic Sweetman (Morgan Kaufman, ISBN: 1558604103).*
- *Liu, Y. H., & Gibson, D. (2017). Microcomputer Systems: The 8086/8088 Family (3rd ed.). Prentice Hall.*
- *Mazidi, M. A., & Mazidi, J. (2014). The 8051 Microcontroller and Embedded Systems (2nd ed.). Pearson.*

7- Working environment (Facilities necessary for learning)

- *MARS simulator*
- *SPIM simulator*
- *Arduino IDE*

Course Specification

CAD (Computer Aided Design)

1. General

Coded	*ELEC 3 210*	Level / Semester	*1/S2*	Coefficient	*1.5*	Credits	*3*
Course	*Electrical engineering*					Volume. H. (CI)	
Responsible	*Nadia HAJJI*					Volume. H. (TP)	*42*
Teaching methods	interactive, direct instructions,Project Based					Self study H.	*32*
Module	*CAD (Computer Aided Design)*					Version	*09/2023*

Course description (Course objective):
Allow the student to carry out engineering projects by handling editing and simulation software for circuits and electrical diagrams.

Prerequisites :	*Keywords :*
Basic electrical circuits, electronics, electrical diagram	*Conception, Numirical*

Specific objectives of the course (OBJ):
OBJ 1 : *Using a software tool, predict the behavior of an electrical circuit for which the diagram is provided or determined based on specifications.*
OBJ 2 : *Conduct a functional analysis for a small project.*

Necessary material :
Computers

2- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
1	*Introduction to Proteus software for the study and simulation of electrical circuits.*	*3H*	*-Sizing of components in electrical circuits* *-Simulation and validation of an electrical circuit*
2-5	*Introduction to ARES for the Design of electrical circuits*	*12*	*-Study the specifications to design printed circuits.* *- Create component packages.* *-Generate 3D diagrams* *- Generate templates for drawing electronic cards.*
	Introduction to Eagle Software	*12*	*-Sizing of components in electrical circuits*

6-9			*-Simulation and validation of an electrical circuit* *- Design of electrical circuits*
10-13	*Introduction to AutoCAD Electrical software*	*12 p*	*- Know how to use AutoCAD software (know the basic functions, the different commands (Line, OFFSET, Trim, Mirror, etc.)* *- Know how to make an architectural, electrical,*
14	*Practical exam, mini-project defense, ...*	*3h*	*Summative evaluation*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	x *Yes* ☐ *No*	*20%*
DS - Supervised Duty	☐ *Yes* x *No*	
EE - Written test (Final exam)	☐ *Yes* x *No*	
EP - Practical test (TP- TP exam / MP- Mini project)	x *Yes* ☐ *No*	*80%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents* : ☐ *Yes* x *No*
- *Authorized search engine* : ☐ *Yes* x *No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *Auto* desk: for Eagle and AUTOCAD
- Proteus
- Hore, P. (2013). Electrical CAD: A Practical Guide (2nd ed.). Newnes.
- Bishop, R. H. (2005). The Mechatronics Handbook (2nd ed.). CRC Press. (Contient des sections pertinentes sur l'utilisation du CAD pour la conception électrique).

7- Working environment (Facilities necessary for learning)

- *None*

Course Specification

Probability and Statistics

1.General

Coded	ELEC 3 211	Level/Semester	1/S2	Coefficient	1.5	Credits	2
Course	*Engineer*					Volume H. (CI)	*21h*
Responsible	*Ben Haj Mbarek mohamed Hedi*					volume. H. (TP)	*0*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*27*
Module	*Probability and Statistics*					Version	*09/2023*

Course description (Course objective):
study of the laws governing random events, including the collection, analysis, interpretation, and display of numerical data.

Prerequisites:	*Keywords :*
Basic algebra	*- Probability* *- Statistics* - random experience

Specific objectives of the course (OBJ):
Upon completion of this module, the student will be able to: OBJ 1: random variable study. OBJ 2: Variance and standard deviation calculation.

Necessary material :
RAS

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-3	Chapter 1: Introduction to probability calculation 1. Basic concepts 2. Probable space and probability 3. Conditional probability 4. Independence of events 5. Bayes formula	*4h30*	*At the end of this chapter, the student will be able to:* knowledge of the conditional probability and Independence of events

4-6	Chapter 2: Counting Methods and Probabilistic drawing schemes 1. Enumeration method: combinatorial analysis 2. Probabilistic drawing schemes: urn models	*4h30*	Combinatorial analysis , Permutations , Arrangements , Combinations and Urn models
7-10	Chapter 3: Random variables 1. General and distribution function 2. Discrete random variables 3. Continuous real random variables 4. The moment generating function 5. Transformation of random variables	*6h*	*able to calculate the* Mathematical expectation, variance and standard deviation
11-14	Chapter 4: Usual laws 1. Discreet laws 2. Continuous laws	*6h*	*Knowledge of different usual laws*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ■ *No*	
DS - Supervised Duty	■ *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	■ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ■ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents* : ☐ *Yes* ■ *No*
- *Authorized search engine* : ☐ *Yes* x *No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

https://math.univ-lyon1.fr/irem/IMG/pdf/PolyTunis_A_Perrut.pdf

- Bernard Courtebras , *At the school of probability* , Press univ . Franche-Comté, 2006, 282 p.
- Bernard Courtebras , *Mathematizing chance,* Vuibert, 2008
- Virginie Delsart and Nicolas Vaneecloo , *Statistical methods of economics and management* , Presses Univ. Septentrion, 2010, 317 p.

7- Working environment (Facilities necessary for learning)

None

Course Specification

Numerical analysis

1.General

Coded	*ELEC 3 212*	Level/Semester	*1/S2*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical engineering*					Volume. H. (CI)	*21h*
Responsible	*Zied Garbouj*					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*29*
Module	Numerical analysis					Version	*09/2023*

Course description (Course objective):
This course allows students to gain advanced knowledge of mathematics and develop skills to solve engineering problems using mathematical techniques.

Prerequisites:	*Keywords :*
L1 and L2 mathematics courses *Mathematical tools at a BAC+2 level*	*- Dies* *-Determinant of a matrix* *-Functions with a real variable*

Specific objectives of the course (OBJ):
Upon completion of this module, the student will be able to: **OBJ 1:** Numerically solve a system of linear equations. **OBJ 2:** Solve nonlinear equations numerically.

Necessary material :
RAS

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-3	*Chapter 1: Solving a system of linear equations using direct and iterative methods* *.-Introduction :* ** Definition of a system of equations.* ** Existence and uniqueness of the solution.* ** Resolution by the Cramer method.-*	*4.5*	*At the end of this chapter, the student will be able to:* *1-Show the existence and uniqueness of a solution of a system of linear equations.*

4-6	*The exact methods:* ** Gauss's pivot* ** LU decomposition* ** comparison of the two methods (calculation cost).*	4.5	*Apply LU decomposition to decompose a matrix.* *3-Describe and Apply the Gauss and LU method to solve a system of linear equations.*
7-9	*- Iterative Methods:* ** General principle* ** Jacobi's method:* ** The Gauss-Seidel method* ** Comparison of the two methods*	4.5	*4-Describe and Apply the Jacobi and Gauss-Seidel method to solve a system of linear equations.* *5-Cite the convergence conditions of the Jacobi and Gauss-Seidel methods*
10-12	*Chapter 2: Solving non-linear equations* *-Application examples* *-Existence and uniqueness* *-The dichotomy method:* **Definition* **The dichotomy algorithm* **Estimated number of iterations* **Order of convergence* **Application*	4.5h	*At the end of this chapter, the student will be able to:* *1-Define the Dichotomy method.* *2-Calculate the number of iterations necessary to solve* *a non-linear equation by the dichotomy method with a given precision.*
13-14	*Newton's Method:* **Definition* **Convergence condition (Choice of x_0)* ** Newton's algorithm* **Order of convergence* **Application* *- Comparison between the two methods.*	3h	*3-Define Newton's method.* *4-Define the convergence conditions of Newton's method.* *5-Discuss the choice of the initial solution of Newton's method.* *6-Compare the Dichotomy method and Newton's method*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ■ *No*	
DS - Supervised Duty	■ *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	■ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ■ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes ■ No*
- *Authorized search engine : ☐ Yes x No*
- *Criterion 1: Understanding of the content (4 points)*
- *Criterion 2: Application of knowledge (10 points)*
- *Criterion 3: Critical analysis (4 points)*
- *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *Grégoire Allaire "Numerical analysis and optimization: An introduction to mathematical modeling and simulation*
- *https://celene.insacvl.fr/pluginfile.php/79706/course/overviewfiles/Analyse%20Num%C3%A9rique%20Cours%20ver%202022_2023.pdf*
- *Burden, R. L., & Faires, J. D. (2015). Numerical Analysis (10th ed.). Cengage Learning.*
- *Keller, H. B. (1992). Numerical Methods for Engineers (2nd ed.). McGraw-Hill.*

7- Working environment (Facilities necessary for learning)

RAS

Course Specification

AC machines

1. General

Coded	ELEC 4 203	Level / Semester	2/S3	Coefficient	3	Credits	3
Course	Electrical engineering					Volume. H. (CI)	21h
Responsible	Nadia HAJJI					Volume. H. (TP)	21h
Teaching methods	Lecture, interactive, direct instructions					Self study H.	33
Module	AC machines					Version	09/2023

Course description (Course objective):
Allow the student to understand the operation of rotating alternating current electrical machines (asynchronous machines and synchronous machines) based on the principles of electromagnetism. *In addition, this course allows you to understand the characteristics specific to different types of machines and their importance in the industrial field.*

Prerequisites :	*Keywords :*
Electrotechnics, basic notions of electromagnetism, Electrical network, Direct current machines	*Asynchronous machine , synchronous machine*

Specific objectives of the course (OBJ):
OBJ 1 : *Understand how synchronous machines work as alternators and motors.*
OBJ 2 : *Understand how asynchronous machines work as generators and motors.*

Necessary material :
Asynchronous machine (with squirrel cage and rings), Synchronous machines (with smooth poles and with salient poles), autotransformer, field rheostat, starting rheostat, measuring devices, dynamo-tachometer, three-phase loads.

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-2	*General information on alternating current machines*	6H	*Understand the operation of alternating current machines and their constitutions, concept of rotating magnetic fields, drive system, load torque and its variations.*
3-5	*Study of synchronous machines*	9	*-Stator winding, rotating magnetomotive force: fmm . circular, fmm . elliptical, three-phase armature supplied by unbalanced currents, single-phase armature, winding coefficient.*

			- *Alternator operation: Principle, e.m.f. induced* - *Alternators with smooth poles: Magnetic armature reaction, Equivalence coefficient, synchronous reactance diagram, Poitier diagram* - *Salient pole alternator: Magnetic armature reaction, diagram with two synchronous reactances, Blondel diagram.* - *Characteristics: reading of P and Q, Load characteristics of an isolated alternator, Load characteristics of an alternator connected to a powerful network, Characteristics of the synchronous motor.* - *Alternator coupling: Parallel operation of charged alternators.* - *Synchronous motor operation: starting and coupling to the synchronous motor network.*
6-7	*Study of asynchronous machines*	*6H*	*-Motor operation: Constitution, operating principle of the three-phase induction motor, slip, operation under load, equivalent single-phase diagram, circular diagram (Construction and use), characteristics.* - *Asynchronous motor tests: load test with measurement of useful power, load test with evaluation of losses, use of the circular diagram.* - *Start-up study: start-up by secondary rheostat, start-up by reduction of the primary voltage.* - *Speed variation: action on the slip, variation in power frequency.* - *Single-phase asynchronous motor: principle, characteristics, starting, use.* - *Single-phase collector motor with series excitation: principle, switching, characteristic diagram, uses.* - *Generator operation: characteristics, areas of use.*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
1	*Study of the alternator three-phase*	*6*	***constant synchronous reactance and Potier diagrams:*** - *determine the load characteristic V(I) at constant cos ϕ directly by a load test and indirectly by means of two direct current test diagrams* - *empty test* - *short circuit test* - *dewattage test.* ***Two synchronous reactance diagram:*** *HAGA test.*
2	*Connection of the synchronous machine*	*6*	*Mordey 's characteristics : attach an alternator to the electrical network and determine the variations of the induced current as a*

	to the network: operation as a synchronous motor		*function of the excitation current I(J) at constant power P. How it works in compensator synchronous will also be studied .*
3	*Study and modeling of the three-phase asynchronous motor*	6	*determine the different losses in an asynchronous motor, namely: stator joule losses - rotor joule losses - stator iron losses - rotor iron losses - mechanical losses - useful power. To carry out this work it is necessary to carry out: a no-load test, with a short-circuited rotor (or blocked rotor) – no-load transformer test – reversed motor test (short-circuited stator).* *Determine the elements of the equivalent diagram.*
4	*Study of the three-phase asynchronous motor under load: Linear model and circle diagram.*	3	*Determine, by measurement and simulation, the following characteristics: C(g) (torque as a function of slip - C(I1) (torque as a function of absorbed current)* *– C(cos ϕ) 'torque as a function of power factor*
12	*Practical exam, mini-project defense, …*	3	*Summative evaluation*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	x *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	x *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	x *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes x No*
- *Authorized search engine : ☐ Yes x No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *Luc Lasne , Electrical energy: Electrotechnics - Magnetism - Machines – Networks, Edition Dunod, 2018*
- *Guy Séguier, Francis Notelet , Industrial electrical engineering, Edition Lavoisier, 3rd edition, 2006.*
- *Wildi, T. (2006). Electrical Machines, Drives, and Power Systems (6th ed.). Pearson.*
- *Nagrath, I. J., & Kothari, D. P. (2010). Electrical Machines (4th ed.). Tata McGraw-Hill.*

7- Working environment (Facilities necessary for learning)

- *None*

Course Specification

Power electronics 1

1. General

Coded	*ELEC 4 104*	Level / Semester	*2/S3*	Coefficient	*2.25*	Credits	*3*
Course	*Electrical engineering*					Volume. H. (CI)	*21h*
Responsible	*Souha Boukadida*					Volume. H. (TP)	*10:30*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*40*
Module	Power electronics 1					Version	*09/2023*

Course description (Course objective):
- Acquiring the basic Notions of power electronics. - Know the functioning of semi - conductors of power at rpm of commutation .

Prerequisites :	*Keywords :*
Analog Electronics	*Single-phase and three-phase rectification, controlled and uncontrolled.*

Specific objectives of the course (OBJ):
• *Power electronics components: Thyristor, Triac, NPN bipolar transistors, switching transistors.* • *Uncontrolled rectification: Single-phase single-wave rectification, Double-wave rectification with midpoint transformer, Single-phase double-wave rectification by Graëtz bridge (PD2), Three-phase single-wave rectification (P3), Three-phase rectification by Graëtz bridge (PD3), Filtering, Rectification not ordered on industrial loads.* • *Controlled rectification: Single-wave rectification with thyristor, Double-wave controlled rectification (PD2), All-thyristor three-phase bridge (PD3), Applications.*

Necessary material :
PSIM software

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-2	*Components power electronics*	*3H*	Know the operating principle of some power electronics components.
3-5	*Unordered recovery*	*9*	*Study the different arrangements:* *- Single-phase single-wave rectification;* *- Double-wave rectification with mid-point transformer, Single phase double-wave rectification by Graëtz bridge (PD2); Graêtz bridge rectification (PD3), Filtering, Uncontrolled rectification on industrial loads.*

6-8	Recovery order	*9am*	*Study the different arrangements:* - *Single-wave rectification with thyristor,* - *Controlled double-wave rectification (PD2),* - *All-thyristor three-phase bridge (PD3), Applications.*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
9-10	Simple and double uncontrolled single - phase adjustment .	3h	The student must master the different assemblies: - PD2 assembly (flow on a resistive load, on an RC load and on an RL load). - P2 assembly.
11-12	Right tri ph a s é not ordered .	3h	The student must master the different assemblies: - P3 assembly (flow on a resistive load, on an RC load and on an RL load). - PD3 assembly.
13-14	Controlled single - phase and three - phase rectification .	4:30	The student must master the different assemblies: - Bridge mounting mixed - P3 assembly based on thyristors. - PD3 assembly based on thyristors.

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☒ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Criteria devaluation

- *Authorized documents* : ☐ *Yes* ☒ *No*
- *Authorized search engine* : ☐ *Yes* ☒ *No*

- *Criterion 1: Understanding of the content (4 points)*
- *Criterion 2: Application of knowledge (10 points)*
- *Criterion 3: Critical analysis (4 points)*
- *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Overview of Power Electronic Devices And Their Characteristics

Power Electronics and Power Systems - NC State ECE

Rashid, M. H. (2013). Power Electronics: Circuits, Devices, and Applications (4th ed.). Pearson.

Mohan, N., Undeland, T. M., & Robbins, W. P. (2003). Power Electronics: Converters, Applications, and Design (3rd ed.). Wiley.

7- Working environment (Facilities necessary for learning)

- *None*
- *...*

Course Specification

Industrial automation and API

1. General

Coded	*ELEC 4 105*	Level / Semester	*2/S3*	Coefficient	*3*	Credits	*3*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*MHALLA ANIS*					Volume. H. (TP)	*21*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*29*
Module	*Automation industrial and API*					Version	*09/2023*

Course description (Course objective):
- Identify the constituent elements and model a production chain using Grafcet *- Study and master the programming of an Industrial Programmable Controller: API* *- Know the architecture and control of automated systems.* *- Carry out supervision of an automated industrial installation*

Prerequisites :	*Keywords :*
Power electronics, electrical diagram, logic systems, automatic	...

Specific objectives of the course (OBJ):
OBJ 1 : *Modeling of automated systems using the GRAFCET tool* ***OBJ 2 :*** *Translate GRAFCET into equations that can be implemented using APIs* ***OBJ 3 :*** *Program a GRAFCET with different programming languages*

Necessary material :
S7-1200 PLCs, TP models (water tank, intersection lights, cylinders, etc.) Computer

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-2	**General information on automated systems** : General information , Representation of **an** automated **system** , Operational part – control part interfaces , **Acquisition**	*3h*	*Master the constituents of an automated system*

	chain and chain of action , Different approaches to automation , Sensors, pre - actuators and actuators.		
3-4	**Industrial Programmable Controllers** : Introduction, Internal structure of a PLC (Microprocessor, Memory , Input - output interfaces , Power supply) , Operation, Environment of a Programmable controller, Criteria for choosing a PLC, Interpretation and application program , Cyclic operation , Processing structure, Industrial inputs and outputs, Connection, PLC environment , Automation levels , Examples of automata: characteristics and performances.	*3h*	*Know the main elements of an API*
5-6	GEMMA : Family of procedures (operating , stopping and fault procedures) , Study of the most common operating modes, Study of the most common stopping modes , Selection modes and conditions of evolution between them.	*3h*	*Master the graphic study guide for on-off modes*
7-8	**GRAFCET:** Introduction, Basic concepts, Levels, Rules of evolution , Different points of view, Different structures , Macro - step	*3h*	*Master the operating modeling of an automated system using GRAFCET*
9-11	**Implementation of a GRAFCET** : Equation of a GRAFCET, General rule , Different cases of equation , Management of start , stop and start **modes** emergency stop , wiring .	*4:30*	*Translate GRAFCET into equations*
12-14	**PLC programming languages** : Introduction, Structure of a program, Functional blocks, Standardized languages , Comparison between different languages , Instruction set, Main industrial programmable controllers, Applications .	*4:30*	*Implement equations with multiple programming languages*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals

1-2	***Introduction to the use of the TIA PORTAL software*** *: Creation of a project, choice of CPU for a Siemens brand PLC, hardware configuration (system flags, cadence flags, high-speed counter (HSC), PWM, etc.), presentation of program blocks, API variables, etc.*	*3h*	*Become familiar with the TIA PORTAL software*
3-5	***API programming using SFC and FBD language*** *: become familiar with SFC programming (GRAFCET) and programming using the flowcharts of a GRAFCET sequence.*	*4:30*	*Master the SFC and FBD programming languages*
6-8	***API programming using Ladder and SCL language*** *: become familiar with Ladder programming for both variants (asynchronous and synchronous) and programming using the SCL language.*	*4:30*	*Master the Ladder and SCL programming languages*
9-10	***Command for filling a water tank*** *: Command for a TP model for filling a tank via an s7-1200 API.*	*3h*	*Know how to program a filling control system*
11-12	***Automation of a traffic light*** *: manage the different operating modes of a model of a traffic light using an S7-1200 API.*	*3h*	*Know how to program a fire management system*
13-14	*Practical exam*	*3h*	*Summative evaluation*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☑ *No*	
DS - Supervised Duty	☑ *Yes* ☐ *No*	
EE - Written test (Final exam)	☑ *Yes* ☐ *No*	
EP - Practical test (TP - TP exam)	☑ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Criteria devaluation

- *Authorized documents : ☐ Yes ☑ No*
- *Authorized search engine : ☐ Yes ☑ No*
  - *Criterion 1: Understanding of the content (4 points)*

- *Criterion 2: Application of knowledge (10 points)*
- *Criterion 3: Critical analysis (4 points)*
- *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Manufacturing applications of automation and robotics

F. Basile, P. Chiacchio and D. Gerbasio, "On the Implementation of Industrial Automation Systems Based on PLC," in IEEE

Transactions on Automation Science and Engineering, vol. 10, no. 4, pp. 990-1003, Oct. 2013, doi: 10.1109/TASE.2012.2226578.

Bolton, W. (2021). *Programmable Logic Controllers* (7th ed.). Butterworth-Heinemann.

Mohan, P. (2003). *Industrial Automation and Robotics*. Laxmi Publications.

7- Working environment (Facilities necessary for learning)

- *None*
- *...*

Course Specification

Systems analysis and control

1. General

Coded	*ELEC 4 106*	Level / Semester	*2/S3*	Coefficient	*2.25*	Credits	*3*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*Hassani Messaoud*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*43.5*
Module	*Systems analysis and control*					Version	*09/2023*

Course description (Course objective):
Master certain industrial process control methods

Prerequisites :	*Keywords :*
Systems linear , systems enslaved	*Analysis , synthesis , corrections*

Specific objectives of the course (OBJ):
OBJ 4 : *Systems modeling* ***OBJ 5 :*** *Tools analysis* ***OBJ 6 :*** *Digital correction synthesis techniques*

Necessary material :
Computers

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-3	***Chapter 1: Modeling systems in state space*** *- Definition of the equation of state* *- Passage from an equation of state to a transfer function* *- Solving the equation of state* *- Case of multivariable systems* *- Exercises*	*4.5*	*Understand the concept of the equation of state and its advantages compared to the transfer function*
4	***Chapter2: Analysis of systems in state space*** *- Controllability: Concept of controllable system, controllability matrix, controllability condition*	*1.5*	*Understand the concept of controllability of a system*

5	*Observability: Concept of observable system, observability matrix, observability condition, exercises*	1.5	*Understand the concept of observability of a system*

6-8	***Chapter 3: Identifying Systems linear***
	- *System and model*
	- *Identifying model parameters*
	  • *Non-recursive least squares method*
	  • *Least method squares recursive*
	- *Exercises*
		4.5	*Learn how to identify the parameters of a model governing an unknown system*

9-11	***Chapter 4: Control by the dominant pole method*** - *Presentation of the dominant pole method* - *Structure of the corrector* - *Method for summarizing corrector parameters* - *Order law* - *Exercise*	4.5	*Understand the principle of synthesizing a digital corrector and its implementation*
12-14	***Chapter 5: Control by the pole placement method*** - *Presentation of the pole placement method* - *Structure of the corrector* - *Method for summarizing corrector parameters* - *Order law* - *Exercise*	4.5	*Understand the principle of synthesizing a digital corrector and its implementation*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
11	***Identification of the parameters of a second order model*** - *Acquisition of input output measurements* - *Non- recursive method* - *Method recursive*	3	*Validate the results theoretical*
12	***Implementation of the dominant pole method*** - *Determination of the control law* - *Implementation* - *Tracing output, reference and order*	3	*Understand the implementation of numerical control methods*
13	***Implementing the pole placement method*** - *Determination of the control law* - *Implementation* - *Tracing output, reference and order*	4.5	*Understand the implementation of numerical control methods*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☒ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Criteria evaluation

- *Authorized documents : ☐ Yes ☒No*
- *Authorized search engine : ☐ Yes ☒No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Systems Analysis and Control - Lecture 1 - Matthew M. Peet

Control System Analysis - an overview

EE 3413: Analysis and Design of Control Systems

ME 4555: System Analysis and Control

Ogata, K. (2010). Modern Control Engineering (5th ed.). Prentice Hall.

Dorf, R. C., & Bishop, R. H. (2016). Modern Control Systems (13th ed.). Pearson.

7- Working environment (Facilities necessary for learning)

- *None*
- *...*

Course Specification

Advanced techniques

1. General

Coded	*ELEC 4 107*	Level / Semester	*2/S3*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical engineering*					Volume. H. (CI)	*21h*
Responsible	*Faycal Hamdaoui*					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*28*
Module	Advanced techniques					Version	*09/2023*

Course description (Course objective):
This course allows students to master and know how to use advanced techniques, namely fuzzy logic, neural networks and genetic algorithms.

Prerequisites :	*Keywords :*
Optimization course, algebra course, basic automatic course	*Neural networks, fuzzy logic, genetic algorithms*

Specific objectives of the course (OBJ):
OBJ 1 : *Know the different parts of a fuzzy inference system and know how to use it to develop complex applications.* ***OBJ 2 :*** *Know and know how to use the basic models of neural networks and associated learning algorithms.* ***OBJ 3 :*** *Know how to use genetic algorithms to solve optimization problems*

Necessary material :
Course support + board

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1	*Fuzzy logic: Introduction, Fuzzy set theory, Membership function, Fuzzy operations*	*1.5h*	*OBJ 1*
2	*Fuzzy logic: Fuzzy reasoning, Deffuzification ,*	*1.5h*	*OBJ 1*
3	*Fuzzy logic: Fuzzy inference system: Rule basis and inference, fuzzy PID*	*1.5h*	*OBJ 1*
4	*Logic fuzzy : directed work*	*1.5h*	*OBJ 1*
5	*Artificial Neural Networks: Principle of operation of the neuron, artificial neural networks*	*1.5h*	*OBJ 2*
6	*Artificial Neural Networks: General model of the artificial neuron, Characterization of ANNs, non-looped networks,*	*1.5h*	*OBJ 2*

7	*Artificial Neural Networks: Multilayer Perceptrons (MLP: Multilayer Perceptron), Recurrent Networks*	*1.5h*	*OBJ 2*
8	*Artificial Neural Networks: Learning ANNs (supervised and unsupervised)*	*1.5h*	*OBJ 3*
9	*Artificial Neural Networks: tutorials*	*1.5h*	*OBJ 3*
10	*Artificial Neural Networks: tutorials*	*1.5h*	*OBJ 3*
11-12	*Algorithms genetics : principle*	*3h*	*OBJ 3*
13-14	*Algorithms genetics : tutorials*	*3h*	*OBJ 3*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
...	...	...	...
...	...	...	...

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	☐ *Yes* ☐ *No*	
EE - Written test (Final exam)	☐ *Yes* ☐ *No*	
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : Yes*
- *Authorized search engine : No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Introduction to Neural Network in Machine Learning

Neural Network - an overview

Fuzzy Systems: Concepts, Methodologies, Tools, and Applications (3 Volumes)

Advances in Fuzzy Systems

Rashid, M. H. (2013). *Power Electronics Handbook: Devices, Circuits, and Applications (3rd ed.). Butterworth-Heinemann.*

Chiasson, J. N. (2005). *Modeling and High-Performance Control of Electric Machines. Wiley-IEEE Press.*

7- Working environment (Facilities necessary for learning)

- *None*

Course Specification

Programming and Embedded Systems Engineering

1. General

Coded	*ELEC 4 108*	Level / Semester	*2/S3*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical engineering*					Volume. H. (CI)	*21h*
Responsible	*Ihsen Jabri*					Volume. H. (TP)	
Teaching methods	interactive, direct instructions,Project Based					Self study H.	*28*
Module	Programming and Embedded Systems Engineering					Version	*09/2023*

Course description (Course objective):
The objective of this module is to familiarize students with a tool development widely used today in network applications; language of ***Python*** script . The student must also master the implementation on a microcontroller (Raspberry PI) and learn to work in parallel under a "standard" **Linux and on a Raspberry Pi** , by synchronizing the two and being able to run the first executables on Raspberry Pi.

Prerequisites :	*Keywords :*
• Systems information and programming	*Programming, Raspberry*

Specific objectives of the course (OBJ):

OBJ 1 : Introduce the fundamental notions of the Python language.

OBJ 2 : Know how to write or interpret scripts applied to system operations in Python

OBJ 3 : Getting to know the Raspberry Pi microprocessor system

OBJ 4 : Study the main components of the chosen card: processor, memory, communication bus, GPIO, interrupt controller, input/output interfaces

OBJ 5 : Connect different modules to the microcontroller: sensors (ultrasonic sensor, temperature sensor, etc.), actuators (current motor, displays (LCD display, 7-segment display, etc.), camera, etc.

OBJ 6 : Carry out the microcontroller programming steps (development in C, python, embedded Linux, etc.), ensure debugging and loading of the application on the memory and finally test and validate the system.

Necessary material :
Raspberry PI board , sensors, actuators

2- Content elements (Course)

Week (s)	Activities / Content elements	No. HR	Goals
1-2	Introduction to the Python Language	*3h*	1. Variables, types of variables and their operators 2. Inputs/outputs3. Simple and nested conditions4. Simple and nested loops
3-4		*3h*	5. Functions 6. Modules7. Containers8. Some advanced programming concepts
5-6	Getting started with the Raspberry Pi board	*3h*	Implementation of the GPIO port of the Raspberry Pi board **.**
	Connecting a DHT11 Temperature and Humidity Sensor with Raspberry Pi		Learn programming with python to read the temperature and humidity value from the DHT11 sensor connected to a Raspberry Pi
7-8	Connecting an HC-SR04 Ultrasonic Sensor with Raspberry Pi card	*3h*	Learn how to connect an ultrasonic sensor to a Raspberry Pi board with a python script.
9-11	Connecting a PIR motion sensor with Raspberry Pi card	*4:30*	Master connecting a motion sensor to a Raspberry Pi card and programming it with Python.
12-14	Practical case	*4:30*	*Global evaluation*

3- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	x *Yes* ☐ *No*	*20%*
DS - Supervised Duty	☐ *Yes* ☐ *No*	
EE - Written test (Final exam)	☐ *Yes* ☐ *No*	
EP - Practical test (TP- TP exam / MP- Mini project)	× *Yes* ☐ *No*	*80%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

4- Criteria devaluation

- *Authorized documents* : ☐ *Yes* ☐ *No*
- *Authorized search engine* : ☐ *Yes* ☐ *No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

5- Web references (useful links):

1. E.Jakobowicz , Python for the data scientist *“* From the basics of language to machine learning , Dunod, 2019.
2. https://www.raspberrypi.org/
3. Tero Karvinen , Kimmo Karvine and Ville Valtokari *“Sensors for Arduino and Raspberry Pi* ” Éditions Dunod, 2014
4. Charles Bell “ *Beginning sensor networks with arduino and raspberry pi* ” Springer Libri, 2014
5. François MOCQ “ *Raspberry Pi 3 or Pi Zero – Exploit the full potential of your nanocomputer* » Editions ENI, 2016

6- Working environment (Facilities necessary for learning)

- *None*
- ...

Course Specification

Signal transmission

1. General

Coded	*ELEC 4 109*	Level / Semester	*2/S3*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical Engineering*					Volume. H. (CI)	*21h*
Responsible	*Hassani Messaoud*					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*28*
Module	*Signal transmission*					Version	*09/2023*

Course description (Course objective):
Present different methods of modulation and demodulation of signals for their transmission

Prerequisites :	*Keywords :*
Signal processing	*Modulation, Demodulation , AM, FM, PM*

Specific objectives of the course (OBJ):
OBJ 1 : *Understand the purpose and principle of modulation*
OBJ 2 : *Know the different types of analog modulation*
OBJ 3 : *Understand the principle of demodulation with a view to recovering the transmitted signal*

Necessary material :
…

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1	***Chapter 1: Signal modulation*** - *Insufficient signal energy to transmit* - *Concept of modulation: Modulating, carrier, modulated* - *Different types of analog modulation*	*1.5*	*Understand the concept of modulation*

2-3	***Chapter 2: Amplitude Modulation : AM*** - *Principle* - *AM Signal Expression and Tracing* - *Modulation index* - *AM Signal Spectrum: Sidebands* - *AM signal energy*	*3H*	*Understanding the shape and expression of an AM signal*

	- *Exercises*		
4-5	***Chapter 3: Frequency modulation : FM*** - *Principle* - *FM Signal Expression and Tracing* - *Modulation index* - *Frequency excursion* *Exercises*	*3H*	*Understanding the shape and expression of an FM signal*
6-7	***Chapter 4: Phase modulation: PM*** - *Principle* - *PM Signal Expression and Tracing* - *Modulation index* - *Frequency excursion* *Exercises*	*3H*	*Understanding the shape and expression of a PM signal*
8-9	***Chapter 5: Demodulation Amplitude*** - *Principle of demodulation amplitude* - *Selection of the signal to detect* - *Modulated signal rectification* - *Peak detection* - *Elimination of the DC component* - *Exercises*	*3H*	*Understand the techniques for restoring the molding signal from the AM signal*
10-12	***Chapter 5 : Frequency demodulation*** - *Transformation of a frequency modulated signal into an amplitude modulated signal* - *Application of the amplitude demodulation method* *Exercises*	*4:30*	*Understand the techniques for restoring the molding signal from the FM signal*
13-14	*Tutorials*	*3H*	*Understanding the course*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☒ *Yes* ☐ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes ☒No*
- *Authorized search engine : ☐ Yes ☒No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

http://materiel-physique.ens-lyon.fr/Logiciels/CD%20N%C2%B0%203%20BUP%20DOC%20V%204.0/Disk%201/TEXTES/1995/07710229.PDF

https://pedagogie.ac-toulouse.fr/sii/system/files/2021-07/10-Act1-MODEM_NUM.pdf

Haykin, S., & Moher, M. (2010). *Introduction to Analog and Digital Communications (2nd ed.). Wiley.*

Lathi, B. P., & Ding, Z. (2009). *Modern Digital and Analog Communication Systems (4th ed.). Oxford University Press.*

7- Working environment (Facilities necessary for learning)

- *None*
- *...*

Course Specification

Sensors and actuators

1. General

Coded	*ELEC 4 110*	Level / Semester	*2/S3*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical engineering*					Volume. H. (CI)	*21*
Responsible	*Souha Boukadida*					Volume. H. (TP)	*0*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*27*
Module	sensors and actuators					Version	*09/2023*

Course description (Course objective):
- Raise students' awareness of the measurement chains used in Electrical Engineering. - Analyze the problems related to the amplification and transport of weak signals in the presence of common mode. - Present instrumentation and isolation amplifiers. - Know different types of sensors and actuators, and understand how industrial instruments (sensors, actuators) work.

Prerequisites :	*Keywords :*
Electronic analog	*Sensor, measuring chain, conditioner, actuators.*

Specific objectives of the course (OBJ):
• Measurement chains • Different types of sensors • Pneumatic actuators • Actuators hydraulic • Actuators electric

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-4	Measurement chains	*6H*	Know the metrological characteristics as well as the conditioning assemblies of passive sensors.

5-8	Different types of sensors	*6H*	*Study the different sensors:* *- temperature sensor (metallic resistors, thermistors and the thermocouple;* *- displacement sensor;* *- and level sensor.*
9-14	Actuators	*9*	-Pneumatic actuators -Hydraulic actuators -Actuators electric

3- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☒ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☒ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

4- Criteria devaluation

- *Authorized documents : ☐ Yes ☒ No*
- *Authorized search engine : ☐ Yes ☒ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

5- Web references (useful links):

Sensors and Actuators: Technology and Applications

Sensors and Actuators - 1st Edition - D.A. Hall

Fraden, J. (2016). *Handbook of Modern Sensors: Physics, Designs, and Applications (5th ed.). Springer.*

Bolton, W. (2015). *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering (6th ed.). Pearson.*

6- Working environment (Facilities necessary for learning)

- *None*
- *…*

Course Specification

Programmable Circuits

1. General

Coded	*ELEC 4 111*	Level / Semester	*2/S3*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical engineering*					Volume. H. (CI)	*21h*
Responsible	*Lotfi Boussid*					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*27*
Module	*Programmable Circuits*					Version	*09/2023*

Course description (Course objective):
Study, design and production of programmable logic circuits

Prerequisites :	*Keywords :*
Number systems, Combinatorial logic, sequential logic	*PLA, PAL, GAL, CPLD, FPGA & ASIC*

Specific objectives of the course (OBJ):

Part I:

OBJ 1 : *Master number systems (natural numbers, relative numbers, fixed-point fractional numbers, single and double-precision floating-point real numbers);*

OBJ 2 : *Master the design of digital circuits based on combinatorial and sequential logic;*

OBJ 3 : *Master the use of RAM & ROM memory circuits*

Part II:

OBJ 4 : *Master the programming of PLA, PAL, GAL & PLD circuits;*

OBJ 5 : *Master the programming of CPLD & FPGA circuits;*

OBJ 6 : *Introduction to the principle of manufacturing ASIC circuits*

Necessary material :
None

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-3	▪ *CH1. History of microelectronics* ▪ *CH2. Coding of information*	*4:30*	***OBJ1***

4-5	▪ *CH3. Combinational logic and logic gates* ▪ *CH4. Sequential logic and sequential circuits*	*3h*	***OBJ2***
6-7	▪ *CH5. RAM & ROM memory circuits*	*3h*	***OBJ3***
8-14	▪ *CH6. PLA and PAL programmable logic circuits* ▪ *CH7. Complex programmable logic circuits (CPLD)* ▪ *CH8. Programmable gate arrays (FPGA)* ▪ *CH9. Specific integrated circuits (ASIC)*	*10:30*	***OBJ4*** ***OBJ5*** ***OBJ6***

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	X *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	X *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes X No*
- *Authorized search engine : ☐ Yes X No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *Lionel TORRES, "Reconfigurable Circuits: Past, Present, Future", LIRMM/POLYTECH, University of Montpellier II, http://www.lirmm.fr*
- *Brian HOLDSWORTH, Clive WOODS, "Digital Logic Design", Forth Edition, eBook ISBN: 9780080477305.*
- ***Maxfield, C. (2004).** The Design Warrior's Guide to FPGAs: Devices, Tools, and Flows. Newnes.*
- ***Ashenden, P. J. (2010).** Digital Design: An Embedded Systems Approach Using VHDL. Morgan Kaufmann.*

- *Bertrand Le Gal, "Digital circuit technology - FPGA circuits", ENSEIRB-MATMECA - Bordeaux INP, Talence, France 2014.*
- *Stephen Brown, Zvonko Vranesic, « Fundamentals of Digital Logic with VHDL Design, Second Edition, ISBN-10 : 0077221435, 2008.*
- *Gabriel Cormier, Ph.D., ing. « Memoire et logique programmable », Université de Moncton, Cours – Chapitre 2, 2015.*
- *Ian Grout, « Digital systems design with FPGAs and CPLDs-Elsevier Newnes », ISBN-13: 978-0-7506-8397-5, 2008.*
- *Jan Friso Groote, Logic Gates, Circuits, Processors, Compilers and Computers-Springer, ISBN-10 : 3030685527, 2021.*
- *Catherine Catherine Douillard, Digital electronic course, "Sequential Logic", Telecom Bretagne.*
- *Pirre Langlois, "Programmable logic Networks and circuits PLA, PAL, GAL and CPLD", INF3500: Design and implementation of digital systems, http://creativecommons.org/licenses/by-nc-sa/2.5/ca/*

7- Working environment (Facilities necessary for learning)

None

Course Specification

LabView

1. General

Coded	*ELEC 4 112*	Level / Semester	*2/S3*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical Ingeneering*					Volume. H. (CI)	
Responsible	*Adnen Albouchi*					Volume. H. (TP)	*21h*
Teaching methods	interactive, direct instructions,Project Based					Self study H.	*26*
Module	*LabView*					Version	*09/2023*

Course description (Course objective):
LabVIEW is a graphical programming environment used by engineers to develop automated research, measurement, validation, and production test systems. It provides developers with configurable and active display elements, drivers to automate instruments, and data acquisition hardware. Additionally, it allows connectivity of other industry standard languages and protocols.

Prerequisites :	*Keywords :*
Algorithms and programming, data structures, data acquisition	*Graphical environment, Virtual instruments, Data acquisition, connectivity and test automation, instrument drivers, modular programming, Labview Real-Time.*

Specific objectives of the course (OBJ):

OBJ 1 : Understanding of the LabVIEW environment: *Gain in-depth knowledge of the LabVIEW interface and features.*

OBJ 2 : User Interface (UI) Development: *Learn to design and create intuitive graphical user interfaces for LabVIEW applications.*

OBJ 3 : Visual Programming: *Master graphical programming using flow charts to create LabVIEW applications.*

OBJ 4 : Using Add-ons: *Discover and use LabVIEW add-ons to extend development functionality.*

OBJ 5 : Preparation for level 1 certification (CLAD): *Prepare for possible LabVIEW certification to validate the skills acquired.*

Necessary material :
Computers

2- Content elements (Practical work)

Week (s)	Chapters / Content Items	No. HR	Goals
1-2	***Chapter I: G Programming and LabView*** - *domain of use .* - *Components of a VI, Front Panel, Diagram.* - *Types of variables and connections, Search for commands, Functions and selection of a tool.* - *Structure of a LabVIEW program (.vi) and construction of a simple VI.* - *Quiz*	*03*	*Know graphical programming, the interface and features of LabVIEW and the structure of a vi.*
3-4	***Chapter II: Troubleshooting and Debugging:*** - *LabView help utilities , development and debugging techniques, error handling.* - *LabView Data Types , Data Flow, VI Timing.* - *Quiz.*	*3*	*Effectively identify and resolve programming problems.*
5-6	***Chapter III: Development applications Modular*** - *Modularity under LabView , creation of a Sub-Vis, assignment of connectors and editing of Icons.* - *Reuse of Sub-Screws.* - *Quizzes* **.**	*03*	*Discover and use LabVIEW add-ons to extend development functionality.*
7-8	***Chapter IV: iterative and conditional structures*** - *Loops (While , For), structures (Condition, multiple choice, Sequence).* - *Data feedback in loops, tunnels, shift registers.* - *Quizzes* **.**	*3*	*Use control structures and loop structures correctly.*
9-10	***Chapter V: Tables, Graphs, Clusters and Files*** - *Concept, construction and basic functions of tables.* - *Data clusters, errors .* - *Clusters assemble/ disassemble .* - *Data tracing and graph types.* - *File types, file I/O vi (high levels, low levels and LabView files Measurements (. lvm).* - *Quiz.*	*03*	*Group, present and record data (tables, graphs, files).*
11	*Getting started with the LabVIEW environment and implementation of the first program (.vi), manipulation of variables, creation and use of Sub-Vis.*	*1.5*	*Learners how to effectively navigate the LabVIEW interface and use basic features.* *Understand dataflow programming.*
12	*Programming iterative structures and conditional structures.*	*1.5*	*Correct use of control structures and loop structures.*

13	*Manipulation of tables, plotting and recording of data (graphs).*	1.5	*Manipulation of tables and recording of data.*
14	*Practical exam (TP Exam).*	1.5	*Summative evaluation .*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	x *Yes* *No*	*20%*
DS - Supervised Duty	☐ *Yes* ☐ *No*	
EE - Written test (Final exam)	☐ *Yes* ☐ *No*	
EP - Practical test (TP- TP exam / MP- Mini project)	☑ *Yes* ☐ *No*	*80%*

- ***Material 100% TP : Average = 20% CC + 80% EP***
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes ☑No*
- *Authorized search engine : ☐ Yes ☑No*
- *Criterion 1: Assess learners' ability to effectively navigate the LabVIEW interface and use basic functionality. (* ***03 points*** *)*
- *Criterion 2: Assessment of the ability to create user-friendly and intuitive user interfaces (* ***02 points*** *)*
- *Criterion 3: Assessment of the ability to use flow charts to develop functional and structured programs. (* ***05 points*** *)*
- *Criterion 4: Correct use of control structures and loop structures (* ***05 points*** *).*
- *Criterion 5: Assessment of the ability to effectively identify and resolve programming problems. (* ***05 points*** *)*

6- Web references (useful links):

- *Author, Title , URL, Year*
- *National Instruments, LabVIEW Help: Official National Instruments (NI) documentation, https://www.ni.com/documentation/en/labview/ , The documentation is updated regularly.*
- *National Instruments, LabVIEW Basics I: National Instruments Online Course, https://learn.ni.com/training?node=16354231 , Course availability may vary.*
- *Travis, J., & Kring, J. (2007). LabVIEW for Everyone: Graphical Programming Made Easy and Fun (3rd ed.). Prentice Hall.*
-
- *Bitter, R., Mohiuddin, T., & Nawrocki, M. (2006). LabVIEW: Advanced Programming Techniques (2nd ed.). CRC Press.*

7- Working environment (Facilities necessary for learning)

- *None*
- *LabVIEW, at least 2020, https://www.ni.com/en/support/downloads/software-products/download.labview.html#487445*

Course Specification

Power electronics 2

1. General

Coded	*ELEC 4 203*	Level / Semester	*2/S4*	Coefficient	*2.25*	Credits	*3*
Course	*Electrical engineering*					Volume. H. (CI)	*21*
Responsible	*Souha Boukadida*					Volume. H. (TP)	*10h30*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*39*
Module	Power electronics 2					Version	*09/2023*

Course description (Course objective):
• And study the function of the choppers. • Study the operation of switching power supplies. • And study the operation of its single - phase and three - phase inverters .

Prerequisites :	*Keywords :*
electronic of power 1	Choppers; single-phase and three-phase switching power supplies and inverters .

Specific objectives of the course (OBJ):
- Study the functi on of the choppers (Direct Choppers ; Indirect Link Choppers and Reversible Choppers) . - Study the operation of switching power supplies (Flyback Structure and Forward Structure). - And study the operation of its single - phase and three - phase inverters .

Necessary material :
PSIM software

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-4	Chopper Assemblies	*6H*	Choppers: Direct choppers (Series, parallel), Indirect connection choppers (Inductive accumulation, capacitive accumulation), Reversible choppers (In current, in voltage, doubly reversible).
5-9	*Switching power supply*	*7:30*	• Role and domain application • Flyback structure • Forward structure
10-14	Inverters	*7:30*	• Role and domain applications • Inverters single phase • Inverters three-phase

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
7-9	Chopper Assemblies	3h	- Study of series and parallel choppers. - Study of reversible current choppers and 4-quadrant choppers.
9-11	*Switching power supply*	3h	- Study of a switching power supply
11-13	Inverters	4:30	- Study of inverters single phase - Study of inverters three-phase

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☒ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Criteria devaluation

- *Authorized documents : ☐ Yes ☒ No*
- *Authorized search engine : ☐ Yes ☒ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Overview of Power Electronic Devices And Their Characteristics Power Electronics and Power Systems - NC State ECE

Rashid, M. H. (2014). *Power Electronics: Circuits, Devices, and Applications* (4th ed.). Pearson.

Mohan, N., Undeland, T. M., & Robbins, W. P. (2012). *Power Electronics: Converters, Applications, and Design*

(3rd ed.). Wiley.

7- Working environment (Facilities necessary for learning)

- *None*
- *…*

Course Specification

VHDL technology and synthesis

1. General

Coded	ELEC 4 204	Level / Semester	2/S4	Coefficient	2.25	Credits	3
Course	Electrical Engineering					Volume. H. (CI)	21
Responsible	Abdessalem ben Abdellaoui					Volume. H. (TP)	10:30
Teaching methods	Lecture, interactive, direct instructions					Self study H.	43
Module	Electronic					Version	09/2023

Course description (Course objective):
Learn to design a digital electronic system through VHDL modeling, simulation in a given development environment and RTL/Logic synthesis.

Prerequisites :	*Keywords :*
digital electronics	*Hardware architecture, hardware design, VHDL, simulation, synthesis, FPGA*

Specific objectives of the course (OBJ):

OBJ 1 : *Understand the basic concepts of designing complex integrated digital electronic systems and circuits: The stages of modeling, simulation and synthesis, representation models, notions of levels of abstraction and type of description, typical design flow: Syntheses at the system, behavioral, register transfer, logical and physical levels*

OBJ 2 : *Be able to write a VHDL description with its different entities: declaration of libraries, entity , architecture, etc.*

OBJ 3 : *Be able to describe the structure of a complex digital system through a structural description using several components to be mapped to constitute the architecture of the system*

OBJ 4 : *Differentiate between concurrent instruction and sequential instruction from a form and application point of view*

OBJ 5 : *Be able to describe combinatorial and sequential components using sequential and concurrent instructions*

OBJ 6 : *Be able to describe the behavior of the architecture of a complex digital system by associating the behavioral processes of the combinatorial and sequential components that compose it one by one or by associating the behavior of several components in the same process*

OBJ 7 : *Be able to write a tesbench in VHDL and perform developed system simulation*

OBJ 8 : *Be able to go through the different stages of designing a digital system from modeling to implementation on FPGA through the synthesis and implementation stages*

Necessary material :
PC, FPGA card

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-2	***Chapter I: Basic concepts of digital integrated circuit design*** - *Introduction to the digital design of complex electronic systems and circuits: The stages of modeling, simulation and synthesis* - *Representation models: Concepts of levels and domains* - *Typical design flow: Syntheses at the system, behavioral, register transfer, logical and physical levels* - *HDL models and specification languages* - *VHDL interest in the design*	*3* *(2x1.5)*	***OBJ1:*** *Understand the basic concepts of designing complex integrated digital electronic systems and circuits*
3	***Chapter 2: VHDL design units and description types*** - *Description of an entity: Entity (ENTITY)* - *Description of an architecture* - *Description of a configuration* - *Package Description* - *General structure of a VHDL description* - *Description types:* *Structural description* *Data flow type description* *Control flow type description*	*1.5* *(1x1.5)*	***OBJ2:*** *Understand Being able to write a VHDL description with its different entities: declaration of libraries, entity , architecture, etc.*
4-5	***Chapter 3: Hierarchical description with VHDL: structural description*** - *Decomposition of the architecture of a complex digital system into structural elements*	*3* *(2x1.5)*	***OBJ3:*** *Be able to describe the structure of a complex digital system through a structural description*

	- *Structural description*		*using several components to be mapped to constitute the architecture of the system*
6-7	***Chapter 4: VHDL Description of TestBench for Simulation*** - *Structure of a test bench* - *After statement* - *wait statement*	*3* *(2x1.5)*	***OBJ7:*** *Be able to write a testbench in VHDL and perform simulation of the developed system*
8-9	***Chapter 5: VHDL instructions*** - *Concurrent instructions* - *Sequential instructions and the concept of process* - *The concept of signal and variable*	*3*	***OBJ4:*** *Differentiate between concurrent instruction and sequential instruction from a form and application point of view*
10 - 12	***Chapter 6: Description of combinatorial components and sequential components***	*4.5* *(3x1.5)*	***OBJ5:*** *Be able to describe combinatorial and sequential components using sequential instructions and concurrent instructions*
13 - 14	***Chapter 7: Description of a complete system***	*3* *(2x1.5)*	***OBJ6:*** *Be able to describe the behavior of the architecture of a complex digital system*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
7	***Familiarization with simulation tools*** *- Getting started with a simulation tool (ModelSim , simulation under ISE): Creation of a project, Compilation and Simulation of a VHDL description.*	*3* *(1x3)*	***OBJ7:*** *Be able to write a tetbench in VHDL and carry out*

	- Use a test bench to generate the stimuli . *- Organization of a project into different files for simulation (separation of design and Test- bench).*		*the simulation of the developed system*
8	***Simulation of examples of combinational circuits*** *Study the example of adder/subtractor circuits according to a structural description and a behavioral description. The following points will be covered:* *- Hierarchical decomposition of a design* *- Description of arithmetic operators (+ / -) for signed and unsigned numbers* *- Simulation of designs designed for the verification of operations and the extent of representable numbers according to the size in number of bits*	*3* *(1x3)*	***OBJ7:** Be able to write a tetbench in VHDL and carry out the simulation of the developed system*
9	***Simulation of sequential circuit examples*** *Description in VHDL and simulation of a programmable counter: counter / down counter with a loading input, a loading control input, a counting activation input (count-enable), a counting direction control input and a Asynchronous Reset input*	*3* *(1x3)*	***OBJ7:** Be able to write a tetbench in VHDL and carry out the simulation of the developed system*
10	***Synthesis and implementation on FPGA.*** *- Manipulation of FPGA-based cards through the study of the implementation of a binary decoder - 7 segment on a Spartan3/6 FPGA-based card.*	*1.5*	***OBJ 5:** Be able to go through the different stages of designing a digital system from modeling to implementation on FPGA*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☒ *Yes* ☐ *No*	*20%*
DS - Supervised Duty	☒ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*

EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☒ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% CC + 60% EE***

5- Criteria devaluation

- *Authorized documents : ☐ Yes ☒ No*
- *Authorized search engine : ☐ Yes ☒ No*
- *Criterion 1: mastery of language (5 points)*
- *Criterion 2: mastery of the development tool (2 points)*
- *Criterion 3: mastery of the architectural aspect (8 points)*
- *Criterion 4: mastery of the methodological and technical aspect (simulation and synthesis) (5 points)*

6- Web references (useful links):

- *VHDL Tutorial: Learn by Example, F. Vahid and R. Lysecky , J. Wiley and Sons, http://esd.cs.ucr.edu/labs/tutorial/ , 2023*
- *VHDL Tutorial, https://www.javatpoint.com/vhdl , 2023*
- *erry, D. L. (2002). VHDL: Programming by Example (4th ed.). McGraw-Hill Education.*
- *Bhasker, J. (2009). VHDL Primer (3rd ed.). Prentice Hall.*

7- Working environment (Facilities necessary for learning)

- *Simulation and synthesis tool for FPGA*
  - *VIVADO*
  - *ModelSim*

Course Specification

DSP architecture and programming

1. General

Coded	*ELEC 4 205*	Level / Semester	*2/S4*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical engineering*					Volume. H. (CI)	*21h*
Responsible	*Ihsen Jabri*					Volume. H. (TP)	*0*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*27*
Module	*DSP architecture and programming*					Version	*09/2023*

Course description (Course objective):
This course presents basic knowledge on the embedded computer architecture of processors dedicated to different applications of digital signal processing (DSP) and theoretical and practical skills on software and hardware optimization techniques of the applied algorithms. Knowledge of assembly and C programming language is required for understand and execute DSP mechanisms.

Prerequisites :	*Keywords :*
Signal Processing and Mathematics Program from Previous Years	RISC processors, pipeline, addressing modes assembly programming

Specific objectives of the course (OBJ):
At the end of this course the student will be able to understand : the interest, architecture and implementation of the DSP by: **OBJ 1:** Knowledge of Applications and DSP performance **OBJ 2:** Discovery of the Architecture, instructions and specific addressing modes **OBJ 3** : Programming in assembler (linear, real) and in C **OBJ 3** : Mastery of software and hardware optimization techniques

Necessary material :
None

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-3	**Chapter 1 :** RISC processor architecture	*4.5h*	Neuman vs. Harvard Architecture -Addressing modes -Classification of processors -The concept of pipeline -The concept of DELAY SLOTS

4-6	**Chapter 2 :** C6x DSPs	*4.5h*	-C6x processor architecture -DSP performance - Development of applications on a DSP
7-10	**Chapter3:** DSP programming	*6*	-Instruction set / NOPs -Linear assembler programming -Real assembler programming
11-14	**Chapter 4:** Hardware and software pipeline	*6*	-Optimization techniques -Dependency graph -Creation of the scheduling table : Prolog, Loop and Epilog

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* × *No*	
DS - Supervised Duty	× *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	× *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* × *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes × No*
- *Authorized search engine : ☐ Yes ☐ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

[1] A. Tisserand. DSP: processors dedicated to digital signal processing, LIP seminar, 2003.
[2] Bores Signal Processing (www.bores.com)
[3] C. Odet. Course on DSP, INSA Lyon, 2005.
[4] Berkeley Design Technology, Inc. www.bdti.com (June 2006)

7- Working environment (Facilities necessary for learning)

- *None*
- *...*

Course Specification

Image processing

1. General

Coded	*ELEC 4 206*	Level	*2/S4*	Coefficient	*3*	Credits	*3*
Course	*Electrical Engineering*					Volume. H. (CI)	*31.5*
Responsible	*Mehrez abdellaoui*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*26*
Module	*Image processing*					Version	*09/2023*

Course description (Course objective):
This module aims to introduce students to digital image processing techniques from image acquisition, through image enhancement and filtering as pre-processing and arriving at analysis through the study of segmentation in using global and regional approaches. *Master software tools to create algorithms for processing, analyzing and understanding digital images.* *Use of statistical tools for understanding and describing digital images through local descriptors and global descriptors.* *Explore the applications of image processing in different fields.*

Prerequisites :	*Keywords :*
Matrix calculation, digital data coding, digital signal processing, algorithms and programming	*Image enhancement, image filtering, image segmentation, region approach*

Specific objectives of the course (OBJ):
OBJ 1 *: Know the foundations of digital image processing systems.* **OBJ 2** *: Master the acquisition of digital images.* **OBJ 3** *: Master the different spaces of color representation.* **OBJ 4** *: Know the different parameters of the raster image.* **OBJ 5** *: Know the image enhancement tools.* **OBJ 6** *: Know the methods of linear and non-linear filtering of digital images* **OBJ 7** *: Know the methods of frequency filtering of digital images* **OBJ 8** *: Master segmentation methods by thresholding images* **OBJ 9** *: Master segmentation methods using image region approach* **OBJ 10** *: Master the different approaches to image description* **OBJ 11** *: Master image classification models* **OBJ 12** *: Master shape recognition tools.*

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals

1	*Chapter 1 - Introduction to image processing: Basic elements, History, various applications*	*1.5*	*OBJ1*
1-2	*Chapter 2 – Coding and representation of images: Image acquisition, color representation, raster image parameters (histogram, brightness, contrast, entropy),*	*6*	*OBJ 2, 3, 4*
4-5	*Chapter 3 - Image preprocessing: image enhancement (stretching, equalization), filtering (linear and nonlinear), frequency filtering*	*9*	*OBJ 5, 6, 7*
7-8	*Chapter 4 - Image segmentation: neighborhood, connected pixels, region, thresholding-based approach, region-based approaches*	*6*	*OBJ 8, 9*
10-11	*Chapter 5- Image descriptors: local description of images: feature vector, global descriptors (color, texture), local descriptors (SIFT, SURF, Deep features), image classifiers, shape recognition*	*9*	*OBJ 10, 11, 12*

3- Content elements (TP)

Week (s)	Activities / Content elements	No. HR	Goals
3	*TP1: Getting started* *1/ Getting started with the software* *2/ Reading and displaying 2D and 3D images* *3/ Different statistical tools: Histogram, Brilliance, contrast* *4/ Image enhancement techniques*	*1h30*	*OBJ 2, 3, 4*
6	*TP2: Image filtering:* *1/ Linear filtering of digital images* *2/ Non-linear filtering of digital images* *3/ Filtering morphological*	*3*	*OBJ 5, 6, 7*
9	*TP3: Image segmentation:* *1/ Image binarization: global, adaptive and manual method* *2/ Image segmentation by multiple thresholding* *3/ Image segmentation by region approach* *4/ Image segmentation using the K- means method*	*3*	*OBJ 8, 9*
12	*TP4: Description of images:* *1/Co-occurrence matrix* *2/LBP local binary patterns* *4/ Local descriptors: SIFT, SURF* *5/ Application to pairing of images*	*3*	*OBJ 10, 11, 12*

Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ■ *No*	
DS - Supervised Duty	■ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	■ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	■ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

4- Criteria devaluation

- *Authorized documents : ■ Yes ☐ No*
- *Authorized search engine : ☐ Yes ■ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

5- Web references (useful links):

1) *Diane Lingrand . 2004. Introduction to image processing, Vuibert, 2004, 221 p.*
2) *Stéphanie Bigot-Marchand, 2008. Image processing tools, Lille Theses, 107 p.*
3) *Digital Image Processing And Applications, International BookMarket Service Limited, 204 p.*
4) *Nixon, M., Aguado, A. (2019). Feature Extraction and Image Processing for Computer Vision. United Kingdom: Elsevier Science.*
5) *Deep Learning for Computer Vision: Image Classification, Object Detection, and Face Recognition in Python. (2019). (np): Machine Learning Mastery.*

6- Working environment (Facilities necessary for learning)

- *MATLAB, Image Processing Toolbox, Computer Vision Toolbox, Deep Learning Toolbox*
- *Google collaboration*

Course Specification

Interfacing Techniques

1. General

Coded	*ELEC 4 207*	Level / Semester	*2/S4*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical engineering*					Volume. H. (CI)	*0*
Responsible	*Ridha Hajjaji*					Volume. H. (TP)	*21h*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*27*
Module	Interfacing Techniques					Version	*09/2023*

Course description (Course objective):
Through this course, the student must be able to master the interfacing techniques of an embedded system based on microcontrollers and microprocesses in order to: - Carry out one of the interfacings with basic peripherals - Carry out interfacing with different protocols communications (I2C, UART, SPI, CAN) - Carry out interfacing and power circuits - Acquisition and conditioning of an analog signal

Prerequisites :	*Keywords :*
- Microprocessors, Analog and Digital Electronic Microcontrollers, Programmable Circuits	*GPIO, LCD, Processor*

Specific objectives of the course (OBJ):
OBJ 1 : Design and create interfaces with microcontrollers and microprocessors. ***OBJ 2 :*** Interface a processor or microcontroller with peripherals: GPIOs , Keyboard, LCD ***OBJ 3 :*** Know the basic interfaces of a microcontroller: GPIOs , UART, I2C, SPI, CAN, ETHERNET ***OBJ 4 :*** Interface a processor or microcontroller with power devices. ***OBJ 5 :*** Choose and configure interface circuits

Necessary material :
Model based on microcontrollers

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
			…
			…

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
1-2	LED diodes , LED diode matrices , 7-segment displays, keyboard, TFT LCD	*3h*	***OBJ 1***
3-4	Communication through a serial interface between a microcontroller-based card	*3h*	***OBJ 2***
5-6	Acquisition of an analog signal from a temperature or humidity sensor	*3h*	***OBJ 2***
7-9	Communication with specific communication interface circuits: (I2C, SPI)	*4.5*	***OBJ 3***
10-15	Power interface: Control stepper motor, DC motor	*4.5*	***OBJ 4***
13-14	Practical exam, mini-project defense, …	*3h*	*Summative evaluation*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☑ *No*	
DS - Supervised Duty	☐ *Yes* ☑ *No*	*20%*
EE - Written test (Final exam)	☐ *Yes* ☑ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☑ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Criteria devaluation

- *Authorized documents* : ☑ *Yes* ☐ *No*
- *Authorized search engine* : ☐ *Yes* ☑ *No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Pierre-Henri DEJEAN (2016), Interfacing method Interfacing products, Edition Techniques de l'Ingénieur, Jan. 10, 2016
Mansor, M. S., & Mohamad, S. (2013). Interfacing Techniques for Embedded Systems (2nd ed.). Springer.

Bishop, R. H. (2005). The Mechatronics Handbook (2nd ed.). CRC Press. (Contient des sections sur les techniques d'interface pour les systèmes embarqués et la robotique).

7- Working environment (Facilities necessary for learning)

- *None*
- *…*

Course Specification

Embedded Systems for IOT1

1. General

Coded	*ELEC 4 208*	Level / Semester	*2/S4*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical engineering*					Volume. H. (CI)	*21h*
Responsible	*Mouhieddine Belghith*					Volume. H. (TP)	*0*
Teaching methods	Lecture, interactive, direct instructions,Project Based					Self study H.	*27*
Module	*Systems Embedded for IOT1*					Version	*09/2023*

Course description (Course objective):
This course introduces basic knowledge of the Internet of Things (IoT), including components, tools, and analysis by teaching the concepts behind IoT and a look at real-world solutions and applications. In addition, it involves developing an IOT gateway and using IOT platforms.

Prerequisites :	*Keywords :*
The student must control the concepts of development in C++, python	*IOT, sensors , actuators , microcontroller*

Specific objectives of the course (OBJ):
At the end of the session, the student must: **OBJ 1:** Learn the basics of IOT **OBJ 2** : Acquire the basics of on-board electronics **OBJ 3** : Understand the embedded computing basics **OBJ 4** : Master the basics of IOT platforms

Necessary material :
WIFI Node MCU ESP8266/ESP32 module, sensors, actuators

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-3	**Chapter 1 :** IoT Overview	*4.5h*	- Understand the definition and meaning of the Internet of Things - Know the applications of IOT: environment and industry, monitoring and e- health, smart meter and smart grid , Smart City, Agriculture and livestock, Automation, Commerce, Transport and logistics

4-7	**Chapter 2 :** IoT networks	*6*	- Understand the main concepts of LAN networks, mobile networks, LPWAN networks, gateways, SIGFOX network, LORA network, development kits - Development of an IOT gateway and use of an IOT platform. ...
8-11	**Chapter 3:** Tutorials	*6*	Aduino board - Present the electronic components - Present the Arduin development environment - Understand lighting, ON / OFF, dimming, Buzzer, push button - Creation of an IOT gateway
12-14	**Chapter 4:** IoT platforms	*4.5h*	- Create an IoT dashboard - Control by mobile application

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* × *No*	
DS - Supervised Duty	× *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	× *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* × *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes × No*
- *Authorized search engine : ☐ Yes ☐ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- Bahga , Arshdeep and Vijay Madisetti . Internet of Things: a practical approach. Vpt , 2014.
- Fortino , Giancarlo, and Paolo Trunfio , eds . Internet of Things based on smart objects: Technology, middleware and applications. Springer Science & Business Media, 2014.
- aj, P. (2016). Internet of Things: Architecture and Design Principles (1st ed.). Morgan Kaufmann.
- Shah, S. L., & Soni, P. (2017). Embedded Systems and IoT: Architecture, Design, and Implementation (1st ed.). Wiley.

7- Working environment (Facilities necessary for learning)

- *None*

4th Year Embedded systems Major: S4

Course Specification

Sensors Smart

1. General

Coded	ELEC-SE 4 209	Level / Semester	*2/S4*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical Engineering*					Volume. H. (CI)	*10.5*
Responsible	*Lamjed Touil*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*26*
Module	*Sensors Smart*					Version	*09/2023*

Course description (Course objective):
Know and understand the different types of smart sensors. Study the main dedicated interface circuits for interfacing intelligent sensors. Know the advantages and disadvantages of digital smart sensors. In particular, to have the necessary knowledge of the different buses most used for communication with smart buses. In addition, students will be able to distinguish and use the different sensors most used in the industrial field.

Prerequisites :	*Keywords :*
This course requires having a culture in the field of analog electronics.	*Bus Hardware Design, Software Design*

Specific objectives of the course (OBJ):

OBJ 1 : *Know the difference between an ordinary sensor and a smart sensor.*

OBJ 2 : Architecture of a smart sensor

OBJ 3 : *Present the different peripherals linked to a* smart sensor.

OBJ 4 : *Know the different types of smart sensors .*

OBJ 5 : *Know the different types of buses used for communication with smart sensors.*

OBJ 6 : *Demonstrate the need for connected* smart sensors .

OBJ 7 : *To know the architectures of intelligent sensor networks.*

Necessary material :

Software tool: Isis, proteus , arduino IDE ., Vivado .

Platform hardware : ESP32, Raspberry, ZedBoard .

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-2	*From ordinary sensor to smart sensor*	*1.5*	*Introduction to the concept of OS security*
3-4	Architecture of a smart sensor	*1.5*	*Know the basic* architecture of a smart sensor
4-5	*Devices linked to a* smart sensor.	*1.5*	*Study the main peripherals linked to a* smart sensor *.*
6-8	*The different types of smart sensors .*	*1.5*	*The different types of smart sensors .*
8-9	*Study of the different types of buses used for communication with intelligent sensors.*	*1.5*	*Know the different types of buses used for communication with smart sensors*
10-12	Smart sensors *and industrial IoT.*	*1.5*	smart *sensors for industrial IoT*
13-14	*Introduction to intelligent sensor networks.*	*1.5*	*Getting to know smart sensor networks*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
1-2	*Introduction to the Proteus tool*	*1.5*	*To become familiar with the "Proteus" tool*
3-4	*Simulation of assemblies using the proteus tool .*	*1.5*	*Be able to simulate a sensor interface module.*
5-6	*Simulation of an application based on a temperature sensor.*	*1.5*	*To be able to simulate a sensor-based application.*
7-8	*Implementation of an application based on a sensor Using the SPI Bus.*	*1.5*	*Getting to know the SPI bus*
9-10	*Implementation of smart sensors with the I2C bus*	*1.5*	*Getting to know the I2C bus*
11-12	*Implementation of an application based on a smart sensor and remote supervision.*	*1.5*	*Telemetry and remote supervision.*

13	*Practical exam, mini-project defense, …*	*1.5*	*Summative evaluation*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ■	---
DS - Supervised Duty	■ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	■ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	■ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Criteria devaluation

- *Authorized documents : ☐ Yes ■ No*
- *Authorized search engine : ☐ Yes ■ No*
- *Criterion 1: mastery of the subject (8 points)*
- *Criterion 2: Reflection and (5 points)*
- *Criterion 3: Effort made (4 points)*
- *Criterion 4: quality of response and writing (3 points)*

6- Web references (useful links):

https://moodle.uphf.fr/pluginfile.php/78425/mod_resource/content/25/supportPedagogiqueTheme1.pdf
https://hal.science/hal-00403106v1/file/LM16_INERIS_Florent_Brissaud_electro.pdfProteus
http://elearning.univ-biskra.dz/moodle2019/course/view.php?id=3616#section-4
http://elearning.univ-djelfa.dz/course/view.php?id=708
Dinesh, K. (2019). *Smart Sensors and Systems: Innovations and Applications. Springer.*
Patel, R., & Kachwaha, P. (2018). *Smart Sensors and Sensing Technology (1st ed.). Wiley.*

7- Working environment (Facilities necessary for learning)

The Proteus tool
Vivado environment

Course Specification

Embedded Mobile Development

1. General

Coded	ELEC-SE 4 210	Level / Semester	*2/S4*	Coefficient	3	Credits	3
Course	Electrical Engineering					Volume. H. (CI)	21
Responsible	Mouhedine Belghith					Volume. H. (TP)	10.5
Teaching methods	interactive, direct instructions,Project Based					Self study H.	15
Module	Embedded Mobile Development					Version	09/2023

Course description (Course objective):
The “Android Programming” course aims to provide an in-depth understanding of application development for the Android platform. Its goals are to familiarize students with fundamental concepts of mobile development, including creating interactive user interfaces, integrating hardware features such as camera or GPS, and manipulating data. This course also focuses on teaching programming best practices for ensuring compatibility with a diverse range of Android devices, as well as strategies for deploying and publishing apps to the Google Play Store. The ultimate goal is to enable learners to design, develop and deploy functional, intuitive and optimized Android applications, using the appropriate tools and programming languages such as Java or Kotlin , while respecting the standards of the Android ecosystem .

Prerequisites :	Keywords :
• Basic programming knowledge: Understanding of basic programming concepts, such as variables, loops, control structures, functions/methods, and data types. • Familiarity with Java or Kotlin : Prior knowledge of Java or Kotlin programming language would be beneficial as these languages are commonly used for Android application development. • Understanding of software development principles: Knowledge of software development concepts such as data manipulation, event management, project structure, etc. • Mobile operating system basics: General understanding of mobile operating systems, and in particular how the Android ecosystem works.	Android Studio, Activities, Fragments, Intents , Adapters, Views, Resources, Manifest, Services, APIs, Database, Permissions, Material Design, AsyncTask , Retrofit , Firebase , MVVM/MVC Architecture, User Interface Design (UI/UX)), Publication on Google Play Store

Specific course objectives (OBJ):
OBJ 1 : Master Android Fundamentals: Gain a deep understanding of basic Android concepts such as Activities, Fragments, Views, Intents , and Resource Management. **OBJ 2 :** Develop functional applications: Be able to design, develop and deploy functional Android applications using mobile development best practices. **OBJ 3 :** Understand architecture and tools: Learn architectural patterns such as MVVM/MVC, development tools like Android Studio, and the use of APIs to integrate specific functionality.

OBJ 4 : Deploy apps to the Google Play Store: Learn the processes for publishing, deploying, and maintaining apps on the Google Play Store platform, taking into account development best practices to ensure optimal compatibility with various Android devices.

Necessary material :
• A computer with an Android development environment such as IntelliJ IDEA, Eclipse or Android Studio. • Internet access for additional resources, Android documentation and updates.

2- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
01	**Introduction to Android and Android Studio**	3	Understand the fundamentals of Android and become familiar with the development environment
02	**Activities and Intents**	3	Master the creation and management of activities, as well as the use of intents for interactions between components
03	**Fragments and Views**	3	Understanding Fragments and Views for Flexible and Dynamic UI Building
04	**Resource Management**	3	Learn to efficiently manage assets such as images, text strings and layouts
05	**Adapters and RecyclerView**	3	Use Adapters and RecyclerView to Efficiently Display Data in the UI
06	**Interaction with APIs**	3	Integrate external APIs to access external services and data in the application
07	**Permission Management**	3	Understand and implement permission management to ensure application security
08	**Services and Background Tasks**	1.5	Learn how to use background services and tasks for long-running operations
09	**Database and Local Storage**	1.5	Use databases and local storage for data persistence
10	**Material Design**	1.5	Material Design principles and components for an improved user experience
11	**Network Communication and Retrofit**	1.5	Understand network communications operations and use Retrofit to simplify API calls
12	**Google Notifications and Services**	1.5	manage in-app notifications and use Google services like Maps or Firebase
13	**Testing and Debugging**	1.5	Learn best practices for testing and debugging Android applications
14	**Practical Exam**	1.5	Complete a practice exam to assess overall understanding and proficiency in Android application development

3- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☑ Yes ☐ No	20%
DS - Duty to Monitor	☐ Yes ☑ No	
EE - Written test (Final exam)	☐ Yes ☑ No	
EP - Practical test (TP- TP exam / MP- Mini project)	☑ Yes ☐ No	80%

- ***Material 100% TP : Average = 20% CC + 80% EP***
- 100% CI material : Average = 40% DS + 60% EE
- CI+TP material : Average = 20% DS + 20% EP + 60% EE

4- Criteria devaluation

- Authorized documents : ☐ Yes ☑ No
- Authorized search engine : ☐ Yes ☑ No

5- Web references (useful links):

- Official Android Documentation: https://developer.android.com/docs - The official Android documentation provided by Google, containing guides, tutorials and references for developing Android applications.
- Android Developers - Guides: https://developer.android.com/guide - A section of the Android Developer Guides containing detailed resources on various aspects of app development.
- Android Developers - Training: https://developer.android.com/courses - Official courses and training provided by Google to learn how to develop Android applications.
- Stack Overflow - Android: https://stackoverflow.com/questions/tagged/android - A developer community where you can ask questions and find answers about Android development.
- Material Design Guidelines: https://material.io/design - Material Design guidelines and principles , recommended for creating modern, intuitive user interfaces for Android applications.
- Elmasri, R., & Navathe, S. B. (2017). Mobile Computing: Principles and Practice (1st ed.). Pearson.
- Xia, F., Yang, L. T., & Li, C. (2016). Mobile and Wireless Design Essentials (2nd ed.). Wiley.

6- Working environment (Facilities necessary for learning)

- Android Studio: This is the official integrated development environment (IDE) for Android. It includes the tools needed to write, compile, debug and test Android applications. You can download it from the official Android Studio website.
- JDK (Java Development Kit): Android Studio requires a specific version of the JDK. Download and install the JDK compatible with Android Studio from the Oracle site.
- Operating system: Android Studio is compatible with Windows, macOS and Linux. Make sure you have a compatible system to install and run the IDE.
- An Android emulator or physical device: To test your apps, you need an Android emulator built into Android Studio or a physical Android device connected to your computer.
- Internet connection: An Internet connection is useful for downloading SDK packages, updates, and accessing online resources such as documentation, guides, and developer forums.

Course Specification

New technologies for process control

1. General

Coded	ELEC-SE 4 211	Level / Semester	*2/S4*	Coefficient	*1.5*	Credits	*1.5*
Course	*Electrical engineering*					Volume. H. (CI)	*0*
Responsible	*Souha Boukadida*					Volume. H. (TP)	*21*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*28*
Module	*New technologies for process control*					Version	*21/2023*

Course description (Course objective):
The course defines a general view of current new technologies, providing an overview of the impacts, applications and implications of new technologies taken as a whole.

Prerequisites :	*Keywords :*
VHDL	XSG; FPGA; VHDL; Matlab ; deep learning

Specific objectives of the course (OBJ):
Study new technologies for ordering.

Necessary material :
None

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
1-4	Ordering a MAS using XSG	6	- Control of a MAS using new FPGA technology and the XSG tool.

5-8	*Order intelligent*	6	- Control of a DC motor using advanced fuzzy logic and neural network techniques and implementation of this control on the FPGA card.
9-14	*Deep learning*	9	- Learn Machine Learning with Python (practical case).

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☒ *Yes* ☐ *No*	*20%*
DS - Supervised Duty	☐ *Yes* ☐ *No*	
EE - Written test (Final exam)	☐ *Yes* ☐ *No*	
EP - Practical test (TP- TP exam / MP- Mini project)	☒ *Yes* ☐ *No*	*80%*

- ***Material 100% TP : Average = 20% CC + 80% EP***
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents* : ☐ *Yes* ☒ *No*
- *Authorized search engine* : ☐ *Yes* ☒ *No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *https://www.aiche.org/resources/publications/cep/2020/december/industrial-process-control-systems-new-approach-education*
- *Bequette, B. W. (2019). Process Control: Modeling, Design, and Simulation (2nd ed.). Prentice Hall.*
- *Åström, K. J., & Murray, R. M. (2010). Feedback Systems: An Introduction for Scientists and Engineers. Princeton University Press.*

7- Working environment (Facilities necessary for learning)

- *None*

Course Specification

Python for Embedded System

1. General

Coded	ELEC-SE 4 212	Level / Semester	*2/S4*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical engineering*					Volume. H. (CI)	
Responsible	*Ridha Hajjaji*					Volume. H. (TP)	*21*
Teaching methods	interactive, direct instructions,Project Based					Self study H.	*27*
Module	*Python for embedded System*					Version	*09/2023*

Course description (Course objective):
"Python for Embedded Systems" is a targeted course designed to equip learners with the essential skills and knowledge needed to effectively utilize Python in embedded systems development. This course covers fundamental Python programming concepts alongside specialized topics relevant to embedded systems, including microcontroller programming, interfacing with hardware peripherals, resource optimization, and energy management. Through hands-on projects and practical exercises, participants will gain proficiency in leveraging Python for embedded applications, enabling them to develop efficient and scalable solutions for a wide range of embedded systems projects.

Prerequisites :	*Keywords :*
programming , microcontrollers	*Python, system embedded , microcontrollers*

Specific objectives of the course (OBJ):
OBJ 1 : Acquire the knowledge necessary for programming microcontrollers or single- board computers using the Python language intended for embedded systems ***OBJ 2 :*** Explore dedicated libraries for embedded systems and exploit existing platforms. …

Necessary material :
ESP32, EPS8266, Raspberry pi 4

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
		…	…
		…	…

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
1-2	*Getting started with the ESP32/ESP8266 card, programming GPIOs with micropython*	*3h*	*OBJ 1*
3-4	*Acquisition of sensor signals (Humidity, temperature, Pressure, Acceleration, etc.)*	*3h*	*OBJ 1*
5-6	*Networking for a connected object*	*3h*	*OBJ 1*
7-9	*Getting started and configuring the Linux OS-based card (Raspberry pi)*	*4h30*	*OBJ 2*
10-12	*Home automation application with the card (Raspberry pi)*	*4h30*	*OBJ 2*
13-14	*Practical exam, mini-project defense, ...*	*3h*	*Summative evaluation*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☑ *Yes* ☐ *No*	*20%*
DS - Supervised Duty	☐ *Yes* ☑ *No*	
EE - Written test (Final exam)	☐ *Yes* ☑ *No*	
EP - Practical test (TP- TP exam / MP- Mini project)	☑ *Yes* ☐ *No*	*80%*

- ***Material 100% TP : Average = 20% CC + 80% EP***
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents* : ☐ *Yes* ☐ *No*
- *Authorized search engine* : ☐ *Yes* ☐ *No*
    - *Criterion 1: Understanding of the content (4 points)*
    - *Criterion 2: Application of knowledge (10 points)*
    - *Criterion 3: Critical analysis (4 points)*
    - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Understanding Python for embedded systems developers

Python vs. C/C++ in embedded systems The Rise of Python for Embedded Systems

Wolfe, P. (2018). Python Programming for Embedded Systems (1st ed.). Packt Publishing.

Cox, D. (2017). Mastering Embedded Python (1st ed.). O'Reilly Media.

7- Working environment (Facilities necessary for learning)

- *None*

4th Year Industrial Control
Major: S4

Course Specification

Robotics

1. General

Coded	*ELEC-CI 4 209*	Level / Semester	*2/S4*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical engineering*					Volume. H. (CI)	*21h*
Responsible	*Anouar Ben Amor*					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*28*
Module	*Robotics*					Version	*09/2023*

Course description (Course objective):
The objective of this course is to determine a model for a robot

Prerequisites :	*Keywords :*
Mechanical general	Robot, forward and reverse model, dynamic

Specific objectives of the course (OBJ):
OBJ 1 : Direct model
OBJ 2 : *Reverse model*
OBJ 3 : *Model dynamic*

Necessary material :
Robots, computers, control board

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-2	Systems modeling mechanical	*3*	Determination of passage matrices
3-4	Direct model	*3*	Understand how to determine the direct model of a stationary robot
5-6	Jacobian matrix and inverse model	*3*	*Calculation of inverse model of a robot*
7-9	*Model dynamic*	*4.5*	*The expression of the robot's end point rotation and translation speed*

10-12	Calculation of direct robot model by Matlab	*4.5*	*Master Matlab tools to calculate a robot model*
13-14	*Control of fixed robots using a* Raspberry card	*3*	*Robot control by a Raspberry card to carry out a specific task*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	X *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	X *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes ∗ No*
- *Authorized search engine : ☐ Yes ∗ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- Jean-Pierre Merlet Parallel robots - Collection Treatise on new technologies - Robotics

- Etienne Dombre **Analysis and modeling of manipulating robots,** 288 pages, published 10/21/2001

- Craig, J. J. (2005). Introduction to Robotics: Mechanics and Control (3rd ed.). Pearson.

7-Siciliano, B., & Khatib, O. (2016). Springer Handbook of Robotics (2nd ed.). Springer. **Working environment (Facilities necessary for learning)**

- *None*

Course Specification

Control and HMI of industrial systems

1. General

Coded	ELEC-CI 4 209	Level / Semester	2/S4	Coefficient	1.5	Credits	2
Course	*Electrical Engineering*					Volume. H. (CI)	*0*
Responsible	*Kais Bouzrara*					Volume. H. (TP)	*21*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*27*
Module	*Control and HMI of industrial systems*					Version	*09/2023*

Course description (Course objective):
Supervision of an automated system. Extend automation programs with a view to creating human-machine interfaces using Siemens brand consoles.

Prerequisites :	*Keywords :*
Automatic , Automation .	*HMI; industrial systems*

Specific objectives of the course (OBJ):
OBJ 1 : *Master the connection procedure between the PLC and the console via API variables*
OBJ 2 : *Know how to configure certain correctors (PID, etc.) using API programming languages*
OBJ 3 : *Know the techniques for extending the API program to create Human-Machine interfaces*

Necessary material :
S7-1200 PLC, asynchronous motor with incremental encoder, speed variator, KTP700 console, Computer

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-2	…	…	…
3-4	…	…	…
…	…	…	…
11-12			

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
1-2	**Implement a regulation strategy with an API** : acquires and sends analog quantities in a cyclical manner . Concept of period sampling .	*3h*	*Know how to use a logic or analog input associated with a sensor*
3-4	**Supervision of analog and digital quantities for PID control** : Creation of Human Machine interfaces managing certain inputs (analog and digital) under a KTP-700 console and application of the PID corrector.	*3h*	*Know how to manage the variables ensuring communication between PLC and Panel for a PID command*
5-7	**Animation of supervision views :** Identification of the essential quantities which ensure the animation of the supervision views.	*4h30*	*Identify the quantities necessary for animating supervision views*
8-10	**Supervision of the speed of an asynchronous motor** : acquisition of the speed of an asynchronous motor via an incremental encoder and monitoring of its evolution on a KTP700 console.	*4h30*	*Master the operation of the incremental encoder and the speed variator*
11-12	**Monitoring the operation of a pneumatic cylinder** : manage alarms in the event of a malfunction of a pneumatic cylinder during the extension and retraction of the cylinder rod	*3h*	*Know how to manage alarms*
13-14	*Practical exam*	*3h*	*Summative evaluation*

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☑ *Yes* ☐*No*	*20%*
DS - Supervised Duty	☐ *Yes* ☑ *No*	

EE - Written test (Final exam)	☐ Yes	☑ No	
EP - Practical test (TP - TP exam)	☑ Yes	☐ No	80%

- ***Material 100% TP : Average = 20% CC + 80% EP***
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes ☑ No*
- *Authorized search engine : ☐ Yes ☑ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Industrial HMI: Human Machine Interface for industrial use

HMI based industrial control system

Industrial Automation using SCADA, HMI & PLC | Overview
***Bolton, W. (2015).** Mechatronics: A Foundation Course (2nd ed.). Pearson. (Contient des sections sur les systèmes de contrôle et les interfaces homme-machine (HMI) dans les systèmes industriels).*
***John, W. (2016).** Industrial Automation and Process Control (1st ed.). Pearson. (Traite des techniques de contrôle et de la gestion des interfaces dans les systèmes industriels).*

7- Working environment (Facilities necessary for learning)

- *None*
- *…*

Course Specification

Modeling of electrical machines

1. General

Coded	*ELEC-CI 4 209*	Level / Semester	*2/S4*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical engineering*					Volume. H. (CI)	*21*
Responsible	*Nadia Hajji*					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*26*
Module	*Modeling of electrical machines*					Version	*09/2023*

Course description (Course objective):
Allow the student to understand the operation of electrical machines (constitution and operation) and to equate the different laws which describe the operation of these machines in transient and steady state. This course prepares the student for controlling machines by estimating their behavior through simulations.

Prerequisites :	*Keywords :*
Electrical network, Direct current machines, Alternating current machines,	...

Specific objectives of the course (OBJ):
OBJ 1 : *Understand how electrical machines work.* ***OBJ 2 :*** *Establish the equations that describe the operation of electrical machines* ***OBJ 3 :*** *Determine the inputs and outputs of electrical machines to estimate their performance at no load and under load.*

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-5	*Modeling of DC machines*	*7h30*	*Model and study the operation of a direct current machine: Equations in transient mode, state model, transfer functions.*
6-10	*Modeling of asynchronous machines*	*7h30*	*Understand the operating principle of asynchronou machines as motors and generators, model the asynchronous machine, state model and matrix writing, study transformation matrices (Park matrix Clark matrix, Concordia matrix), complex equations*
11-14	*Modeling of synchronous machines*	*6H*	*Understand the operating principle of synchronous machines as motors and alternators, model the synchronous machine, state model and matrix*

			writing, study transformation matrices (Park matrix, Clark matrix, Concordia matrix), complex equations. Model the permanent magnet synchronous machine (MSAP), Model the synchronous machine in saturated mode.

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* x *No*	
DS - Supervised Duty	x *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	x *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* x *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes x No*
- *Authorized search engine : ☐ Yes x No*
    - *Criterion 1: Understanding of the content (4 points)*
    - *Criterion 2: Application of knowledge (10 points)*
    - *Criterion 3: Critical analysis (4 points)*
    - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *R. ABDESSEMED, "Modeling and simulation of electrical machines", Ellipses, Collection , 2011.*
- *J. LESENNE, F. NOTELET, G. SEUIER, "Introduction to in-depth electrical engineering", Technique and documentation, 1981*

Lipo, T. A. (2007). *Introduction to AC Machine Design (1st ed.). Wiley-IEEE Press.*

Fitzgerald, A. E., Kingsley, C., & Umans, S. D. (2003). *Electric Machinery (6th ed.). McGraw-Hill.*

7- Working environment (Facilities necessary for learning)

- *None*
- *...*

Course Specification

Smart control

1. General

Coded	*ELEC-CI 4 212*	Level / Semester	*2/S4*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*Souha Boukadida*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*15*
Module	Smart control					Version	*09/2023*

Course description (Course objective):
• Present the methods and tools necessary for the integration of fuzzy logic and neural networks into industrial process identification and control schemes. • Provide an essential theoretical basis for understanding these approaches and their use in the analysis, synthesis and implementation phases .

Prerequisites :	*Keywords :*
Advanced techniques	Fuzzy logic and neural networks.

Specific objectives of the course (OBJ):
• Order fuzzy processes. • Identification and neural control of processes.

Necessary material :
Software matlab

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-6	*Logic Blurry*	*9*	Principle and topology of a fuzzy controller. Rules of expertise and reasoning techniques. Fuzzification- defuzzication . Setting a fuzzy controller. Links between fuzzy and traditional controllers. Stability of a controller vague . Order Blurry .

7-14	Order neuronal	*12*	*Architecture. Learning. Properties. Areas of application of different types of networks. Examples Application to identification and ordering.*

			Learning algorithms. Methods for identifying systems using neural networks. Neural networks in control schemes .

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
6-8	Order Blurry	4.5	- Creating a controller vague . - Fuzzy identification and control of an application. - Limitations of a fuzzy controller. Application examples and implementation on computer.
8-11	*Order neuronal*	6	- Examples of application of neural networks to identification and control. - Computer implementation of fuzzy and neural control algorithms.

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☒ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Criteria devaluation

- *Authorized documents* : ☐ *Yes* ☒ *No*
- *Authorized search engine* : ☐ *Yes* ☒ *No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Smart Control Pro (URC7966) - One For All Smart Control – Applications sur Google Play

Zhou, K., & Doyle, J. C. (1998). Essentials of Robust Control. Prentice Hall. (Traite des principes de contrôle intelligent et robuste).

Kuo, B. C., & Golnaraghi, F. (2017). Automatic Control Systems (9th ed.). Wiley. (Inclut des approches modernes et intelligentes pour le contrôle des systèmes).

7- Working environment (Facilities necessary for learning)

- *None*

4th Year Biomedical Instrumentation Major: S4

Course Specification

Equipment maintenance 1

1. General

Coded	*ELEC-IB 4 209*	Level / Semester	*2/S4*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*Mouldi Ghdir*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*16*
Module	*Equipment maintenance 1*					Version	*09/2023*

Course description (Course objective):
Maintenance Strategy : standards, MP, MC, M condit, maintenance indicators, cost, diagnostic methods Studies of Biomedical equipment : ECG, Syringe pump, Surveillance monitor, etc.

Prerequisites :	*Keywords :*
Maintenance standards, Mathematics , IT, electronics, sensor classes, etc.	Maintenance , Biomedical equipment

Specific objectives of the course (OBJ):
OBJ 1 : Master the principle and maintenance of functional exploration equipment surveillance **OBJ 2 :** Know the methods of diagnosis, quality control, preventive and corrective maintenance of medical devices (laboratory, operating room, functional exploration) **OBJ 3 :** Know the technical differences in analysis and reliability to repair using diagnostic methods and establish maintenance forecast ***OBJ 4 :*** Knowing how to establish health care planning **OBJ 5 :** Mastering the principle and maintaining ownership of the equipment and devices diagnosis and functional exploration

Necessary material :
…

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-2	*CHI Maintenance strategy: Definition of maintenance according to the NFX60-010 standard, States of equipment, Principle: Maintenance graph and tests, technical platforms, life cycle of equipment*	*3h*	*OBJ 1*
3-4	*CHII: Preventive maintenance* *Systematic preventive maintenance, Conditional preventive maintenance, Quality assurance. Compliance* *Measurement and testing techniques, Establishment of a preventive maintenance plan, Preventive maintenance method*	*3h*	*OBJ 1*
5-6	*CHIII: Corrective and curative maintenance:* *General intervention process, Preparation of intervention management procedures, General methodology of a diagnosis,* *Diagnostic tool (diagram and diagnostic sheet, cause and effect, “ AdD ” or “ AdC ” fault tree, maintenance tree)*	*3h*	*OBJ 2*
7-8	*CH IV: Maintenance indicators:* *Definition of reliability, maintainability , availability, security* *Maintenance service activity indicators, maintenance cost indicators*	*3h*	*OBJ 3*
9-10	*CH IV: ECG: Operating principle, sensors, synoptic diagram, design and production of an ECG, remote monitoring, preventive maintenance and quality control, corrective maintenance*	*3h*	*OBJ 4- OBJ 5*
11-12	*CH IV: Syringe pump: Operating principle, sensors, synoptic diagram, design and production of a syringe pump, remote monitoring, preventive maintenance and quality control, corrective maintenance*	*3h*	*OBJ 4- OBJ 5*
13-14	*CH IV: ECG Monitoring Monitor: Working principle, ECG sensors, SPO2, Temperature, etc., block diagram, Preventive maintenance and quality control, corrective maintenance*	*3h*	*OBJ 4- OBJ 5*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
9-10-11	*ECG, Syringe pump, Monitoring monitor, etc.* *Disassembly, identification of boards, stepper motors, sensor, simulator, etc.*	*9*	*OBJ 5*
13	*Practical case study*	*1h30*	

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	X *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	X*Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	X *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes X No*
- *Authorized search engine : ☐ Yes X No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Guide to Equipment Maintenance Management

Equipment Maintenance: Goals, Types, Program Setup Equipment Maintenance Procedures Guide

onzalez, R. (2017). Biomedical Instrumentation and Measurements (2nd ed.). Pearson. (Couvre les principes fondamentaux des équipements biomédicaux et leur maintenance).

Webster, J. G. (2010). Medical Instrumentation: Application and Design (4th ed.). Wiley. (Traite de la maintenance des instruments médicaux et des équipements biomédicaux).

7- Working environment (Facilities necessary for learning)

- *None*
- *...*

Course Specification

Safety, Maintenance and Sterilization of Biomedical Equipment

1. General

Coded	*ELEC-IB 4 210*	Level / Semester	*2/S4*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical engineering*					Volume. H. (CI)	*21*
Responsible	*Mouldi Ghedir*					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*28*
Module	*Sterilization , Safety and Standards*					Version	*09/2023*

Course description (Course objective):
Equip students with the knowledge and skills to ensure the safety, maintenance, and sterilization of biomedical equipment while adhering to international standards and best practices in healthcare environments.

Prerequisites :	*Keywords :*
Automation, Grafset , electronics , IT, electric , pneumatic, hydrolic	*Standars, safety*

Specific objectives of the course (OBJ):
Obj 1 : identify risks associated with the use of medical devices. ***Obj 2 Apply safety standards to ensure regulatory compliance.*** ***Obj 3 Develop and implement preventive and corrective maintenance plans.*** ***Obj 4 Diagnose common failures and propose appropriate solutions.*** ***Obj 5 Describe various sterilization methods and their applications.*** ***Obj 6 Monitor and validate the effectiveness of sterilization protocols.*** ***Obj 7 Document interventions and ensure the traceability of actions.*** ***Obj 8 Propose improvements to enhance the safety, maintenance, and sterilization of biomedical equipment.***

Necessary material :
…

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-2	***Introduction to Biomedical Equipment Safety*** • *Identification of electrical, mechanical, and biological risks.* • *Safety principles and application of international standards (IEC 60601, ISO 13485).* • *Case studies on safety-related incidents.*	*4.5h*	*OBJ 1, OBJ 2*
5-6	***Maintenance of Medical Devices*** • *Concepts of corrective, preventive, and predictive maintenance.* • *Diagnostic processes for common equipment failures.* • *Development of maintenance schedules based on manufacturers' technical specifications.*	*6h*	*OBJ 3 , OBJ 4*
7-8	***Sterilization Techniques for Medical Equipment*** • *Sterilization methods: autoclave, radiation, chemical agents, and dry heat.* • *Protocols to avoid cross-contamination.* • *Validation and monitoring of sterilization process effectiveness.*	*4.5h*	*OBJ 5, OBJ 6*
9-10	***Documentation and Traceability Management*** • *Recording maintenance and sterilization interventions.* • *Importance of traceability in the lifecycle of medical devices.* • *Analyzing reports for continuous improvement.*	*6h*	*OBJ7, OBJ 8*

2- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
			...

3- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	☐ *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	☐ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

4- Criteria devaluation

- *Authorized documents* : ☐ *Yes* ☐ *No*
- *Authorized search engine* : ☐ *Yes* ☐ *No*
    - *Criterion 1: Understanding of the content (4 points)*
    - *Criterion 2: Application of knowledge (10 points)*
    - *Criterion 3: Critical analysis (4 points)*
    - *Criterion 4: Clarity and organization (2 points)*

5- Web references (useful links):

Disinfection & Sterilization Guidelines Sterilization for Medical Devices Sterilization standards

Barker, P. D. (2018). Medical Device Safety: A Handbook for Engineers and Manufacturers. CRC Press.

Frerichs, J. (2015). Sterilization of Medical Devices: A Practical Guide (1st ed.). Wiley-Blackwell.

Ratner, B. D., Hoffman, A. S., Schoen, F. J., & Lemons, J. E. (2013). Biomaterials Science: An Introduction to Materials in Medicine (3rd Edition). Academic Press.

6- Working environment (Facilities necessary for learning)

- *None*
- *…*

Course Specification

Cell Biology and Microbiology applied to Biotechnology

1. General

Coded	*ELEC-IB 4 211*	Level / Semester	*2/S4*	Coeff icient	*1.5*	Credits	*2*
Course	*Electrical engineering*					Volume. H. (CI)	*21*
Responsib le	*Amani Lahouar*					Volume. H. (TP)	*0*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*26*
Module	biology					Version	*09/2023*

Course description (Course objective):
- Provide students with fundamental knowledge in cell biology and microbiology to understand their applications in biotechnology and biomedical engineering.

Prerequisites :	*Keywords :*
Mathematics for engineers	*Cell, DNA, Microbiology*

Specific objectives of the course (OBJ):
Obj 1 : Understand the structure and function of cells and their components. ***Obj 2 : Explain the role of cellular processes in health and disease.*** ***Obj 3 : Classify microorganisms and describe their growth and reproduction.*** ***Obj 4 : Analyze the importance of microorganisms in biotechnology applications.*** ***Obj 5 : Apply knowledge of genetic engineering in biomedical contexts.*** ***Obj 6 : Use laboratory techniques for cell and microorganism analysis.*** ***Obj 7 : Integrate microbiological and cellular concepts to solve biomedical challenges.***

Necessary material :
Nothing

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-3	***Introduction to Cell Biology*** • *Overview of cell structure and function.* • *Cellular organelles and their roles.* • *Cellular communication and signaling pathways.*	*4.5*	*OBJ 1 ; OBJ 2*
4-6	***Microbiology Basics*** • *Classification of microorganisms: bacteria, viruses, fungi, and protozoa.* • *Microbial growth and reproduction.* • *Role of microorganisms in health and disease.*	*4.5*	*OBJ 3 ; OBJ 4*
7-10	***Biotechnology Applications*** • *Genetic engineering and recombinant DNA technology.* • *Applications of microorganisms in biotechnology (e.g., bioreactors, production of antibiotics).* • *Biosensors and bioassays in biomedical engineering.*	*6*	*OBJ 5*
11-14	***Laboratory Techniques in Cell Biology and Microbiology*** ○ *Microscopy and cell imaging techniques.* ○ *Sterilization and aseptic techniques.* ○ *Culture and identification of microorganisms.*	*6*	*OBJ 6 ; OBJ 7*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* *X* ☐ *No*	
DS - Supervised Duty	X *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	X *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* *X* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes X No*
- *Authorized search engine : ☐ Yes X No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

https://www.merriam-webster.com/dictionary/biology https://www.open.ac.uk/courses/biology

Wilson, M., & Walker, J. (2018). Principles of Biology (7th ed.). Pearson. (Introduction générale à la biologie, utile pour comprendre l'interaction entre les systèmes biologiques et les applications électriques).

Kandel, E. R., Schwartz, J. H., & Jessell, T. M. (2012). Principles of Neural Science (5th ed.). McGraw-Hill. (Couvre les bases de la biologie neuronale et les concepts utiles pour le génie biomédical).

7- Working environment (Facilities necessary for learning)

- *None*

Course Specification

Fundamentals of Anatomy, Physiology and Neurophysiology for Medical Instrumentation

1. General

Coded	ELEC-IB 4 212	Level / Semester	2/S4	Coefficient	1.5	Credits	2
Course	Electrical engineering					Volume. H. (CI)	21
Responsible	Amani Lahouar					Volume. H. (TP)	0
Teaching methods	Lecture, interactive, direct instructions					Self study H.	26
Module	Anatomy – physiology – neurophysiology					Version	09/2023

Course description (Course objective):
- Introduce students to the basic concepts of human anatomy, physiology, and neurophysiology, emphasizing their relevance in the design and application of medical instrumentation.

Prerequisites :	*Keywords :*
Mathematics for engineers	*Apparatus , physiology , anatomy*

Specific objectives of the course (OBJ):
Obj 1 : Understand the anatomical organization of the human body and its major systems.
Obj 2 : Explain the physiological processes of key organ systems.
Obj 3 : Describe the structural and functional components of cells and tissues.
Obj 4 : Analyze the basics of neural communication and its implications in medical devices.
Obj 5 : Correlate physiological principles with medical instrumentation design.
Obj 6 : Interpret physiological signals for diagnosis and monitoring purposes.
Obj 7 : Evaluate the role of neurophysiology in advanced medical instrumentation.

Necessary material :
Nothing

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-3	***Introduction to Human Anatomy and Physiology*** • *Overview of the human body structure.* • *Major systems of the body (cardiovascular,*	*4.5*	*OBJ 1; OBJ 2*

	respiratory, musculoskeletal, etc.). • *Anatomical terminology and directional references.*		
4-6	***Cellular and Tissue Structure*** • ***Basic structure and function of cells.*** • ***Overview of tissues: epithelial, connective, muscle, and nervous tissues.***	*4.5*	*Obj 3*
7-8	***Physiology of Major Organ Systems*** • ***Cardiovascular system: blood flow, heart function, and blood pressure.*** • ***Respiratory system: gas exchange and lung mechanics.*** • ***Musculoskeletal system: muscle contraction and skeletal mechanics.***	*3*	*Obj 4*
9-11	***Introduction to Neurophysiology*** • *Structure and function of the nervous system.* • *Neural communication: action potentials and synaptic transmission.* • *Sensory and motor pathways relevant to medical instrumentation.*	*4.5*	*Obj 4; Obj 5*
12-14	***Applications in Medical Instrumentation*** • *Physiological signals and their measurement (e.g., ECG, EEG, EMG).* • *Role of medical devices in monitoring and diagnosing physiological functions.* • *Case studies on instrumentation for specific organ systems.*	*4.5*	*Obj 6; Obj 7*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals

…	…	…	…
…	…	…	…

4- Methods evaluation & marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* X *No*	
DS - Supervised Duty	X *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	X *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* X *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents* : ☐ *Yes* X *No*
- *Authorized search engine* : ☐ *Yes* X *No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Neuroanatomy and Neurophysiology: A Review Anatomy and Physiology of the Visual System

Marieb, E. N., & Hoehn, K. (2018). Human Anatomy & Physiology (10th ed.). Pearson. (Couvre les bases de l'anatomie et de la physiologie humaines, avec des applications pertinentes pour le génie biomédical).

Kandel, E. R., Schwartz, J. H., & Jessell, T. M. (2012). Principles of Neural Science (5th ed.). McGraw-Hill. (Traite de la neurophysiologie et des bases du fonctionnement du système nerveux, essentiel pour la compréhension des systèmes biomédicaux).

Tortora, G. J., & Derrickson, B. (2017). Principles of Anatomy and Physiology (15th Edition). Wiley.

Kandel, E. R., Schwartz, J. H., Jessell, T. M., Siegelbaum, S. A., & Hudspeth, A. J. (2012). Principles of Neural Science (5th Edition). McGraw-Hill.

7- Working environment (Facilities necessary for learning)

- *None*
- *…*

5th Year Embedded systems
Major: S5

Course Specification

Embedded systems for IoT2

1. General

Coded	*ELEC-SE 5 101*	Level/Semester	*3/S5*	Coefficient	*1.5*	Credits	*3*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*Mrs Ihsen Jebri*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions, Project Based					Self study H.	*41*
Module	Embedded systems for IoT2					Version	*09/2023*

Course description (Course objective):
This course provides the learning outcomes and skills necessary to understand the typical architecture of an IoT network and to set up a complete IoT chain, from the feedback of information emitted by connected sensors to the visualization of data. This course also introduces the security concepts of IoT systems: connected objects, operating systems, networks, applications and data. It will aim to master the basic concepts and fundamental notions of computer security. The focus will be on IoT. Thus, the student will be able to understand the modus operandi of computer attacks targeting the IoT ecosystem, master and understand the roles and operation of the different components and security tools of this ecosystem. This module will also provide the mastery and skills necessary to develop a crypto system for the IoT .

Prerequisites:	*Keywords :*
Embedded systems for IoT 1	Sensor, actuator, cloud, network, microcontroller, IOT platforms

Specific objectives of the course (OBJ):

OBJ 1 : Understand the fundamental notions of IOT: Application areas, IoT challenges, Architecture IoT, Data acquisition and transport, Data processing and analysis, IoT platforms.

OBJ 2 : Know the different standards proposed for short and long distance communications in the IoT, the protocols and multi-layer communication architectures dedicated to the IoT.

OBJ 3 : Support the CISCO Networking Academy online course which is designed to prepare the student for Cisco Iot certification.

OBJ 4 : Identify risks and threats to IoT applications/systems that require cryptographic tools. basic concepts and fundamental notions of cryptography, understand the security aspects of connected objects, develop new security approaches and solutions for IoT systems.

Necessary material :
Software: CISCO Packet Tracer, arduino IDE

Iot Platform: Thinkspeak, blink Materials: ESP8266 Wifi module, sensors, actuators,

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	**Chapter 1:** Communication architectures and protocols for the Internet of Things	*3h*	-General introduction -Communication architectures for IoT- Concepts of gateways and interaction between technologies.
3-6	**Chapter 2 :** Standard technologies at lower layers	*3h*	**Short-range radio communication technologies** - RFID networks - - NFC - -Z-WaveThe RFID protocol The BLE (Bluetooth WPAN (Low-Rate Wireless Personal Area Netw
		3h	**Long-range mobile radio communications technologies** - LoRaWan - Cellular networks: 3G, 4G, 5G SIGFOX
7-9	**Chapter 3:** online course from the CISCO Networking Academy platform on the fundamentals of iot	*4:30*	Presentation of the course and response to questions proposed by CISCO on "the fundamentals of iot"
10-12	**Chapter 4:** Security risks and threats in IoT systems	*4:30*	**Risk analysis:** -Devices -Applications-Communication protocols -Information collection -Platforms and cloud
13-14	**Chapter 5:** Security of IoT systems	3h	**Security objectives:** -Authenticate devices -Secure communications -Secure code to be executed -Secure data backup **Security protocols adapted to IoT**

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
4	Part 1: Design of the connected embedded application and technological choice	*1h30*	• Choice of microcontroller and development board: Arduino, Raspberry Pi, STM32, BeagleBone,

5	Part 2: interfacing the various sensors and actuators with the microcontroller and carrying out the electrical assembly	*1h30*	• Choice of sensor: light meter, camera, ultrasonic sensor, motion sensor, pressure sensor, • Choice of actuator: Relay, motor, LCD screen, ...
6-7	Part 3: Connecting the object to the internet	*1h30*	• Configuration of the connection device: Ethernet, wifi, CAN, Bluetooth,... • Choice of communication protocol: MQTT, CAOP, Lora, Sigfox, Zeegbee • Creation of server and Gateway
8	Part 4: development of the embedded application in C, C++ or Python, etc.:	*3h*	• Debugging and testing • Loading/execution on microcontroller.
11	Part 5: Development of the control application: web application or mobile application		• Choice of programming languages • Installation of the development environment
12	The use of PACKET TRACER (a powerful network simulation software) which allows students to experiment with the behavior of networks by considering different scenarios	*1h30*	Simulation of an IOT network of a secure house equipped with several types of intelligent sensors on CISCO Packet Tracer .
14	Practical exam	*1h30*	Simulation of a smart home equipped with several types of connected objects on Cisco Packet Tracer.

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	× *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	× *Yes* ☐ *No*	*20%*
EP - Practical test (TP- TP exam / MP- Mini project)	× *Yes* ☐ *No*	*60%*

- ***Material 100% TP : Average = 20% CC + 80% EP***
- *100% CI material : Average = 40% DS + 60% EE*

- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents* : ☐ *Yes* ☐ *No*
- *Authorized search engine* : ☐ *Yes* ☐ *No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

[1] Camilo Alejandro Medina, Manuel Ricardo Perez, Luis Carlos Trujillo: IoT Paradigm into the Smart City Vision: A Survey. iThings/GreenCom/CPSCom/SmartData 2017: 695-70
[2] Fei Hu, “Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations”,CRC Press, 2016
[3] Russell and Drew Van Duren “Practical Internet of Things Securit”, Brian, PACKT Publishing, June, 2016[4] Shancang Li and Li Da Xu “Securing the Internet of Things”, Syngress, 2017
[5] Philippe Atelin, Eni, “ Wireless networks 802.11, Technology, deployment, security, 2008.
[6] Sensor networks - Theory and modeling, David Simplot, Ryl Eric Fleury, HermesScience Publications, 2009.[7] Dominique Paret, Xavier Boutonnier, Youssef Houiti, “ NFC (Near Field Communication) - Principles and applications of
near field communication, 2012.
[8] Adrian McEwen and Hakim Cassimally, John Wiley & Sons “ Designing the Internet of Things, 2013 .

7- Working environment (Facilities necessary for learning)

Course Specification

Artificial and Industrial Vision

1. General

Coded	*ELEC-SE 5 102*	Level/Semester	*3/S5*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*Mr Mehrez Abdellaoui*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions, Project Based					Self study H.	*15*
Module	*Artificial and Industrial Vision*					Version	*09/2023*

Course description (Course objective):
This course aims to introduce students to the theoretical and practical foundations of artificial and industrial vision systems. The image acquisition parameters will be detailed in this course by the calibration of the matrix and linear cameras. Practical industrial and artificial mink tools will be presented.

Prerequisites:	*Keywords :*
Image processing, neural networks, programming	*Calibration, acquisition, matrix camera, inspection, object localization*

Specific objectives of the course (OBJ):	
OBJ 1 :	*Know the basic elements of an artificial and industrial vision system*
OBJ 2 :	*Know the types of 1D, 2D and 3D vision systems.*
OBJ 3 :	*Define different types of lighting sources, different geometries, shaping and lighting control*
OBJ 4 :	*Master the geometric model of matrix cameras*
OBJ 5 :	*Know the calibration techniques of matrix cameras*
OBJ 6 :	*Master the different stages of acquiring matrix cameras*
OBJ 7 :	*Master the different stages of acquiring linear cameras*
OBJ 8 :	*Master localization tools by model matching*
OBJ 9 :	*Know object detection tools*
OBJ 10 :	*Know shape recognition tools.*
OBJ 11 :	*Master texture analysis tools using GLCM and LBP.*
OBJ 12 :	*Mastery of programmable artificial vision software tools and the stages of project creation*
OBJ 13 :	*Master a configurable machine vision software tool*
OBJ 14 :	*Application of detection and inspection tools on professional industrial vision software*
OBJ 15 :	*Realization of practical artificial vision project*

Necessary material :
Machine vision software tool, PC

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	*Chapter 1: Introduction to artificial & industrial vision* 1. *Presentation of vision systems* 2. *Types of vision systems* 3. *Lighting systems*	*6*	*OBJ 1, 2, 3*
4-5	*Chapter 2: Camera Calibration* 1. *Geometric model of cameras* 2. *Intrinsic and extrinsic parameters* 3. *Calibration techniques*	*6*	*OBJ 4, 5*
7-8	*Chapter 3: Acquisition devices* 1. *CCD and CMOS sensors* 2. *Monochrome Color cameras* 3. *Matrix cameras* 4. *Linear cameras*	*4:30*	*OBJ 6, 7*
11-12-13	*Chapter 4: Processing tools for machine vision* 1. *Implementation steps* 2. *Model matching localization tools.* 3. *Object detection tools.* 4. *Shape recognition tools* 5. *Texture analysis tools by GLCM and LBP.*	*4:30*	*OBJ 8, 9, 10, 11*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
3	1. *Definition and presentation of specifications for practical artificial vision projects.* 2. *Presentation of the Google colab tool: example of image classification by CNN.* 3. *Presentation of artificial vision datasets on Kaggle.* 4. *Selection and formation of working groups*	*3h*	*OBJ 12, 15*
6	1. *Getting started with professional machine vision software* 2. *Pattern Max object location tools*	*3h*	*OBJ 13, 15*
9-10	1. *Object detection tools* 2. *Shape recognition tools* 3. *Surface Analysis Tools*	*3h*	*OBJ 14, 15*
14	*Evaluation of practical artificial vision projects*	*1h30*	*Summative evaluation*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ■ *No*	
DS - Supervised Duty	■ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	■ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	■ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents* : ☐ *Yes* ■ *No*
- *Authorized search engine* : ☐ *Yes* ■ *No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *Mohamed Elgendy, Deep learning for vision systems, google books, 2000*
- *Youssef Amri, 2014. Industrial Vision. European University Editions, 72 p.*
- *Patrick Bonnin, 2015. The Basics of Image Processing and Industrial and Robotic Vision, EDUMEC, 299 p.*
- *cognex.com: technical documentation and software tools 020*

7- Working environment (Facilities necessary for learning)

- *Insight explorer 6.5.0 (cognex.com software): https://support.cognex.com/en-gb/downloads/detail/in-sight/4531/S1033*
- *Google collab: https://research.google.com/colaboratory/*
- *Kaggle: https://www.kaggle.com/datasets*

Course Specification

Embedded Systems Security

1. General

Coded	*ELEC-SE 5 103*	Level/Semester	*3/S5*	Coefficient	*3*	Credits	*3*
Course	*Electrical Engineering*					Volume. H. (CI)	*21h*
Responsible	*Mr Lamjed Touil*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions,Project Based					Self study H.	*39*
Module	*Embedded Systems Security*					Version	*09/2023*

Course description (Course objective):
Know and understand the different types of attacks that threaten embedded systems. To know the different methodologies and tools for the development of software and hardware solutions dedicated to improving the reliability, robustness and security of embedded systems. In particular, how can we measure the reliability and security of an embedded system. Furthermore, students will be able to distinguish and use the different methods of assessing the reliability of embedded systems.

Prerequisites:	*Keywords :*
This course requires having a culture in the field of digital circuits	*Hardware Design, Software Design*

Specific objectives of the course (OBJ):
OBJ 1 : *Demonstrate the need and usefulness of IP (intellectual properties) and data security in Embedded Systems and Know the basic notions of information security.* ***OBJ 2 :*** *Remember the classic methods of coding information (RZ, NRZ, AMI, Manchester, HDBn, etc.) and introduce new coding techniques* ***OBJ 3 :*** *Present the different standardized or emerging methods of coding and securing data SE As large data streams are processed on Systems on Chips* ***OBJ 4 :*** *Understand ethical hacking techniques to better secure the OS* ***OBJ 5 :*** *present different approaches for securing fixed and dynamic data exchanged through embedded systems and open networks* ***OBJ 6 :*** *Master the use of the notion of the finite state machine for OS security* ***OBJ 7 :*** *Know the security of Systems on a Chip.*

OBJ 8 : *Demonstrate the need and usefulness of IP (intellectual properties) and data security in Embedded Systems. Present the different standardized or emerging methods of coding and securing data in Embedded Systems.* ***OBJ 9 :*** *Know the protection of privacy through scrambling operations.* ***OBJ 10 :*** *Hardware and software implementation of modules dedicated to OS security.* ***OBJ 11 :*** *The idea is to Protect privacy through scrambling operations will also be addressed.*

Necessary material :
HDL simulation tool: Modelsim Summary tool: Vivado. FPGA platform: ZedBoard Zynq-7000 Development Board

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	*The basics of information security*	*3*	*Introduction to the concept of OS security*
3-4	*Peripherals related to the security of Embedded systems.*	*3*	*Know the devices in the security domain*
4-5	*Study of encryption algorithms*	*3*	*Study the most used algorithms in security*
6-8	*Study of information coding methods (RZ, NRZ, AMI, Manchester, HDBn, etc.) in order to adapt to the evolution of applications and transmission or storage media and introduce new coding techniques .*	*3*	*Know the usual coding in Embedded Systems*
8-9	*Study of different simple and complex methods for error detection.*	*3*	*Master error detection methods*
10-12	*Study of different approaches to secure fixed and dynamic data exchanged through embedded systems and open networks.*	*3*	*Know data security approaches*
13-14	*Introduction to cyber security*	*3*	*To become familiar with cyber security*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals

1-2	*Introduction to the "ModelSim" tool*	*1h30*	*To become familiar with the "Model-Sim" tool*
3-4	*Simulation of Hardware modules*	*1h30*	*Be able to simulate a hardware module.*
5-6	*Introduction to the "Vivado" environment*	*1h30*	*To be able to synthesize a hardware module*
7-8	*Implementation of applications on an FPGA platform*	*1h30*	*To implement a Hardware module*
9-10	*Simulation and synthesis of dedicated applications for the security of embedded systems*	*1h30*	*To synthesize a hardware module.*
11-12	*Implementation of OS security applications*	*1h30*	*Be able to implement a Hardware module*
14	*Practical exam, mini-project defense, …*	*1h30*	*Summative evaluation*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ■ *No*	---
DS - Supervised Duty	■ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	■ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	■ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes ■ No*
- *Authorized search engine : ☐ Yes ■ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *https://fr.digi.com/blog/post/key-strategies-for-embedded-systems-security…*
- https://www.researchgate.net/publication/265980679_Introduction_a_la_securite_des_systemes_entreprises_Introduction_a_la_securite_des_systemes_entreprises
- https://exed.centralesupelec.fr/actualites/cybersecurite-securisation-des-dispositifs-vulnerables/
- http://www.catspowerdesign.fr/actualites/systeme-entreprises
- http://deptinfo.cnam.fr/~paradinas/cours/SecuCodeMobileCours(H_W)-PP.pdf
- Heath, S. (2003). Embedded Systems Design: A Unified Hardware/Software Introduction. Elsevier.
- Zhou, X., & Hu, X. (2018). Security in Embedded Systems: Advances and Applications. Wiley.

7- Working environment (Facilities necessary for learning)

The ISE 9 or ISE 14 tool
"ModelSIM" tool
"Vivado" environment

Course Specification

Advanced VHDL: architecture and simulation

1. General

Coded	*ELEC-SE 5 104*	Level/Semester	*3/S5*	Coefficient	*3*	Credits	*3*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*Mr Abdesslem Abdelali*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions,Project Based					Self study H.	*38*
Module	*SW/HW Development of Real Time Systems*					Version	*09/2023*

Course description (Course objective):

This course covers advanced architectures and modeling for the design of complex digital systems. The objective of the course concerns the mastery of the following aspects:

- *Architecture aspect of dedicated hardware systems and performance analysis*
  - *Composition and organization of architectures of complex dedicated hardware systems*
  - *Performance analysis of hardware architectures (latency, cadence, throughput, execution time, propagation paths, etc.).*
- *Advanced VHDL modeling aspect*
  - *The strategy for decomposing a system and the different means of description for VHDL modeling*
  - *The different VHDL description models through practical examples of dedicated hardware architectures*

Prerequisites:	*Keywords :*
digital electronics *VHDL Hardware Description Language*	*Dedicated hardware architecture, hardware design, VHDL, simulation, synthesis, FPGA*

Specific objectives of the course (OBJ):

OBJ 1 : *Acquisition of basic notions of hardware design and design flow of digital integrated circuits and FPGAs*

OBJ 2 : *Study and simulation of the constituent components of the architecture of a complex digital system: combinatorial and sequential components of complex digital systems*

OBJ 3 : *Study of the structure of architectures of complex digital systems: Composition in data path and controller (finite state machines)*

OBJ 4 : *Study and application of performance analysis criteria for a dedicated hardware architecture: Frequency, Latency, Cadence, Throughput, Execution time, etc.*

OBJ 5 : *Study of VHDL modeling methodologies of complex digital circuits for simulation and synthesis*

OBJ 6 : *Study and practice of the different VHDL description models of a hardware architecture: FSM + D, FSMD, behavioral models* ***OBJ 7 :*** *Become familiar with an advanced hardware simulation and synthesis tool*

Necessary material :
PC, FPGA card

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-5	***Chapter I: Introduction*** - *Concept of hardware implementation and software implementation* - *Concept of general-purpose architectures and dedicated architectures* - *Notion of Hardware Design, FPGA Design, HW/SW Design* - *Evolution of complexity of architectures and methods and tools for designing complex digital systems* ***Chapter II: Design approaches for digital integrated circuits (design flow)*** - *Introduction :* - *Section I: Concept of levels of abstraction and domain of description of CIs (behavioral, structural, architectural, physical)* - *Section II: Typical IC design flow: Design levels and stages (system synthesis, RTL synthesis, logical synthesis, physical synthesis, placement and routing)* - *Comparison of design flow of ASICs and FPGAs*	*7.5*	***OBJ 1:*** *Acquisition of basic notions of hardware design and design flow of digital integrated circuits and FPGAs*
6-10	***Chapter III: Dedicated Hardware Architecture: structure and performance*** - *Introduction :* - *Section I: The performance criteria of a dedicated hardware architecture: Frequency, Latency, Cadence, Throughput, Execution time, etc.*	*7.5*	***OBJ 3:*** *Study of the structure of complex digital systems architectures: Composition in*

	- *Section II: Composition of data paths and sequencers and principle of performance analysis of a dedicated hardware architecture* - *Architectural exploration and performance analysis of an example of data flow oriented design* - *Analysis and synthesis of controllers from different Design examples*		*data path and controller* ***OBJ 4:*** *Study and application of performance analysis criteria for a dedicated hardware architecture*
11-14	***Chapter IV: - Advanced VHDL modeling of complex digital systems.*** - *Introduction :* - *Section I: Strategies for decomposing complex systems for VHDL modeling* - *Section II: VHDL modeling and synthesis* - *Section III: Different VHDL description models of a hardware architecture: FSM + D, FSMD, behavioral models* - *Section IV: Practical examples of modeling complex architectures*	*6*	***OBJ 5:*** *Study of VHDL modeling methodologies of complex digital circuits for simulation and synthesis* ***OBJ 6:*** *Study and practice of the different VHDL description models of a hardware architecture*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
2	*Familiarization with the simulation and synthesis tool through simple design examples*	*1.5*	***OBJ7:*** *Become familiar with an advanced hardware simulation and synthesis tool*
4	*Simulation of specific combinatorial and sequential components of complex digital systems*	*1.5*	***OBJ 2:*** *Study and simulation of the constituent components of the architecture of a complex digital system:*

6	*Study of a design example according to the "controller + datapath" architectural model (Miniproject launch)*	*1.5 (2x1.5)*	***OBJ 3:** Study of the structure of architectures of complex digital systems: Composition in data path and controller*
7-8	*VHDL description and controller simulation: different types of finite state machines (Moore and mealy) with different types of outputs (registered/unregistered, implicit/explicit deactivation, etc.)*	*3*	***OBJ 5:** Study of the structure of architectures of complex digital systems: Composition in data path and controller (finite state machine)*
12-13	*Development of the architecture of a data path based on a memory (BRAM, ROM, FIFO, etc.).*	*3*	***OBJ 6:** Study of the different VHDL description models of a hardware architecture*
14	*Practical exam, mini-project defense, …*	*1.5*	*Summative evaluation*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	
EP - Practical test (TP- TP exam / MP- Mini project)	☒ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes ☒ No*

- *Authorized search engine : ☐ Yes ☒ No*
- *Criterion 1: mastery of language (5 points)*
- *Criterion 2: mastery of the development tool (2 points)*
- *Criterion 3: mastery of the architectural aspect (8 points)*
- *Criterion 4: mastery of the methodological and technical aspect (simulation and synthesis) (5 points)*

6- Web references (useful links):

- *F. Vahid and R. Lysecky, J. Wiley and Sons, VHDL Tutorial: Learn by Example, http://esd.cs.ucr.edu/labs/tutorial/ , 2023*
- *Stephen Brown and Zvonko Vranesic, Fundamentals of digital logic with VHDL design, https://theswissbay.ch/pdf/Books/Computer%20science/Fundamentals, Year*
- *Bhasker, J. (2009). VHDL Primer (3rd ed.). Prentice Hall.*
- *Perry, D. L. (2002). VHDL: Programming by Example (4th ed.). McGraw-Hill Education.*

7- Working environment (Facilities necessary for learning)

- *Simulation and synthesis tool for FPGA*
  - *VIVADO*
  - *ModelSim*

Course Specification

SOC prototyping on FPGA

1. General

Coded	*ELEC-SE 5 105*	Level/Semester	*3/S5*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical engineering*					Volume. H. (CI)	*21*
responsible	*Mrs Souha Boukadida*					Volume. H. (TP)	*10:30*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*16*
Module	*SW/HW Development of Real Time Systems*					Version	*09/2023*

Course description (Course objective):
The course aims to introduce SoC design methodologies and their applications based on new generations of programmable circuits called FPGAs.

Prerequisites:	*Keywords :*
Combinatorial and sequential logic, VHDL technology and synthesis, C/C++ programming.	*FPGA, SOC, IP, Xilinx VIVADO (HLS)*

Specific objectives of the course (OBJ):
✓ Understand the purpose, challenges and constraints when designing a system on a chip (SoC) ✓ Know the architectural and technological options available to a designer of digital systems. ✓ Know how to locate the boundary between hardware and software. ✓ Mastery of fine-grain reconfigurable circuits (FPGA). ✓ Design a heterogeneous system (hardware + software) based on the FPGA circuit. ✓ Implement the system on a reconfigurable circuit (SoPC). implementation of complex systems.

Necessary material :
Digilent Zynq-7000 ARM/FPGA SoC Trainer Board.

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-4	System on chip (SoC)	*6*	Know the architectural and technological options available to a digital systems designer Know how to locate the boundary between hardware and software.
5-9	Software and hardware co-design embedded on FPGA	*7:30*	Design the hardware part of specific logic blocks (IP).

			Define the interfaces between processors and peripheral hardware blocks. Design the software executed by the microprocessor to carry out the control part of the application.
10-14	The design flow	*6*	Master the design flow and the tools associated with joint design.

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
7-8	Architectural and technological options for the design of digital systems.	3h	Know the design flow of digital systems from the system and algorithmic level down to the lowest (physical) level.
9-11	The technology of reconfigurable systems continues to grow. And SoPCs present solutions for problems in different fields (Electronic Computing, automation, Telecommunications, etc.).	4:30	Know the composition of SoPCs as well as the communication between the different IP's of a SoPC.
12-13	Implementation of complex systems	3h	The student who has knowledge in the areas: technological; tool; language and development method, it will be able to enter the field of design of systems on programmable chips.

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☒ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*

- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes ☒ No*
- *Authorized search engine : ☐ Yes ☒ No*
    - *Criterion 1: Understanding of the content (4 points)*
    - *Criterion 2: Application of knowledge (10 points)*
    - *Criterion 3: Critical analysis (4 points)*
    - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

FPGA Prototyping and the SoC Design/Verification Process

FPGA Prototyping of System-on-Chip (SoC) Designs

FPGA Prototyping by VHDL Examples: Xilinx MicroBlaze MCS SoC, 2nd Edition
Chung, K. H., & Wang, S. Y. (2010). FPGA Prototyping By VHDL Examples: Xilinx Spartan-3 Version. Wiley.
Barker, A. (2013). Digital System Design with FPGA: Implementation Using Verilog and VHDL. Elsevier.

7- Working environment (Facilities necessary for learning)

- *Title, Version, URL*
- *…*

Course Specification

ARM processor and applications

1. General

Coded	*ELEC-SE 5 106*	Level/Semester	*3/S5*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical engineering*					Volume. H. (CI)	
Option	*Mr Marwen Kermani*					Volume. H. (TP)	*21*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*25*
Module	*ARM processor and applications*					Version	*09/2023*

Course description (Course objective):
Know the internal architecture of the STM32 microcontroller Develop applications based on the STM32 microcontroller

Prerequisites:	*Keywords :*
C++ programming.	STM32 microcontroller, Hal API

Specific objectives of the course (OBJ):
OBJ 1 : Know the internal architecture of the STM32 microcontroller **OBJ 2 :** Know how to address and program the different registers of the STM32 microcontroller ***OBJ 3 :*** Programming by HAL

Necessary material :
Video projector + Table

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
1-2	- ***STM and its applications** : Managing GPIOs with STM32F4*	*3*	Develop GPIO-based applications using HAL APIs
3-5	- **STM and its applications** : Digital Analog DAC and Analog Digital ADC converters based on STM32	*4:30*	Develop applications based on ADCs and DACs using HAL APIs
6-7	- **STM and its applications** : UART communication based on STM32F4	*3*	Know how to use the UART communication protocol of the STM32 microcontroller
8-10	- **STM and its applications** : Implementations of the SPI (Serial Peripheral Interface) bus with STM32F4	*4:30*	SPI bus implementations of the STM32 microcontroller
11-12	- ***STM and its applications** : I2C bus implementations with STM32F407*	*3*	STM32 microcontroller I2C bus implementations
13-14	*Practical exam, mini-project defense, ...*	*3h*	*Summative evaluation*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	*Yes*	*20%*
DS - Supervised Duty	*No*	
EE - Written test (Final exam)	*No*	
EP - Practical test (TP- TP exam / MP- Mini project)	*Yes*	*80%*

- ***Material 100% TP : Average = 20% CC + 80% EP***
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes*
- *Authorized search engine : ☐ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Technical document STM32
A Review of ARM Processor Architecture History, Progress and Applications
Yiu, J. (2011). The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors (3rd ed.). Elsevier.
O'Leary, T. (2012). ARM Assembly Language: Fundamentals and Techniques (2nd ed.). Wiley.

7- Working environment (Facilities necessary for learning)

- *Title, Version, URL*
- *cubMX+ Keil*

Course Specification

Embedded Artificial Intelligence

1. General

Coded	*ELEC-SE 5 107*	Level/Semester	*3/S5*	Coefficient	*3*	Credits	*3*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*Mr Lamjed Touil*					Volume. H. (TP)	*10:30*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*40*
Module	*Embedded Artificial Intelligence*					Version	*09/2023*

Course description (Course objective):
This course offers students: To know the role and usefulness of Embedded Artificial Intelligence or Edge computing which presents an essential component in modern Embedded systems. Study of embedded systems for intelligent and connected objects. To pose and resolve general problems of complex systems, particularly in the fields of engineering, using Artificial Intelligence algorithms. - Understand and analyze the fundamental components of a dedicated hardware architecture for the implementation of *Artificial Intelligence algorithms* responding to future and current challenges in terms of energy and new resources - Study expert systems (forward chaining, backward chaining and mixed chaining). To explore the usefulness of “Mealy” and “Moore” finite state machines to implement intelligent solutions.

Prerequisites:	*Keywords :*
This course requires knowledge of logical systems.	*Hardware Design, Software Design*

Specific objectives of the course (OBJ):
OBJ 1 : *Demonstrate the need and usefulness of Artificial Intelligence.* Embedded systems for intelligent and connected objects ***OBJ 2 :*** Know the basic architecture of an embedded system. ***OBJ 3 :*** *Introduction to embedded systems dedicated to the implementation of Artificial Intelligence algorithms.* ***OBJ 4 :*** *know the different software and hardware implementation solutions for AI algorithms* ***OBJ 5 :*** *Introduction to finite state machines*

OBJ 6 : *Modeling of AI algorithms based on State/Transition Diagrams.*
OBJ 7 : *Master the use of the notion of finite state machine to implement an AI algorithm*
OBJ 8 : *Introduction to inference engines and* study of expert systems.
OBJ 9 : Front chaining, rear chaining and mixed chaining.
OBJ 10 : Introduction to the design of intelligent agents
OBJ 11 : Explore intelligent systems, called multi-agent systems.

Necessary material :
Hardware synthesis tool: ISE **software/hardware** synthesis tool . FPGA platform: ZedBoard FPGA platform; Spartan 3E, Zynq-7000 Development Board.

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	*Need and usefulness of Artificial Intelligence.* Embedded systems for intelligent and connected objects	*1.5*	*Introduction to the concept of OS security*
3-4	*The basics of AI*	*1.5*	*Know the basics of AI*
4-5	*Study of AI Algorithms*	*3*	*Study the most used algorithms in AI*
6-8	Basic architecture of an embedded system.	*3*	Explore the basic architecture of an embedded system.
8-9	*embedded systems dedicated to Artificial Intelligence algorithms.*	*3*	*Introduction to embedded systems dedicated to the implementation of Artificial Intelligence algorithms.*
10-12	*Finite state machines*	*3*	*Introduction to Finite State Machines*
13-14	*AI algorithms based on State/Transition Diagrams.*	*3*	*To know AI algorithms based on State/Transition Diagrams.*
	Expert systems and *inference engine* Chaining Study	*3*	*To have an introduction to expert systems.* To do an Introduction to Forward Chaining, Back Chaining and Mixed Chaining.

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals

1-2	*Introduction to the "ModelSim" tool*	*1h30*	*To become familiar with the "Model-Sim" tool*
3-4	*Simulation of Hardware modules*	*1h30*	*Be able to simulate a hardware module.*
5-6	*Introduction to the "Vivado" environment*	*1h30*	*To be able to synthesize a hardware module*
7-8	*Implementation of FSM on an FPGA platform*	*1h30*	*To implement an FSM on an FPGA*
9-10	*Simulation and synthesis of dedicated applications for AI*	*1h30*	*Be able to implement a chaining algorithm*
11-12	*Implementation of Artificial Intelligence applications*	*1h30*	*To synthesize an AI module.*
13-14	*Practical exam, mini-project defense, ...*	*1h30*	*Summative evaluation*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ■	---
DS - Supervised Duty	■ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	■ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	■ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes ■ No*
- *Authorized search engine : ☐ Yes ■ No*
- *Criterion 1: mastery of the subject (8 points)*
- *Criterion 2: Reflection and (5 points)*
- *Criterion 3: Effort made (4 points)*
- *Criterion 4: quality of response and writing (3 points)*

6- Web references (useful links)

https://www.quantmetry.com/glossaire/ia-aborde/

https://www.entreprises.gouv.fr/fr/numerique/entreprises/intelligence-artificielle-entreprises

https://think.in2p3.fr/definition-intelligence-artificielle-entreprises/

https://www.leti-cea.fr/cea-tech/leti/Pages/recherche-applie/axes-de-recherche/Intelligence-Artificielle-Embarquee/Intelligence-Artificielle-Embarquee-sommaire.aspx

https://www.captronic.fr/IA- embarke-approach-methodologique-technologies-implementation-et-cas-d-usage.html

https://assises.embedded-france.org/wp-content/uploads/2018/09/presentation-assises-entreprises-2017.pdf

Zhao, Z., & Sahoo, B. K. (2020). Embedded Artificial Intelligence for Edge Computing: Design, Applications, and Challenges. Wiley.

Hassan, M. A. (2021). Artificial Intelligence for Embedded Systems: Algorithms, Architectures, and Applications. Springer.

7- Working environment (Facilities necessary for learning)

The ISE 9 or 14 tool
Vivado environment

Course Specification

RFID

1. General

Coded	*ELEC-SE 5 108*	Level/Semester	*3/S5*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical Engineering*					Volume. H. (CI)	
Responsible	*Mr Marzouk Marwen*					Volume. H. (TP)	*21*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*27*
Module	*RFID*					Version	*09/2023*

Course description (Course objective):
▪ *Acquire and deepen the fundamental notions of a Radio Frequency Identification System (RFID).* ▪ *Know how to determine the main performance of an antenna.* ▪ *Ability to distinguish product characteristics and identify and resolve applications of RFID technology.* ▪ *Understand the principles of communication and collision management.*

Prerequisites:	*Keywords :*
Transmission of signals, Wire antennas.	*RFID, transponder, tag, antenna, collision.*

Specific objectives of the course (OBJ):
OBJ 1 : *Understand the working principle of RFID technology, including its advantages and limitations.* ***OBJ 2 :*** *Understand the main types and designs of transponders and their specific regulations.* ***OBJ 3 :*** *Know how to determine the main performances of an antenna: radiation pattern, directivity, gain, etc.* ***OBJ 4 :*** *Understand the principles of communication: Coding and Modulations of signals in the uplink and downlink.* ***OBJ 5 :*** *Be able to use collision management algorithms.*

Necessary material :
Video projector, PC, table.

2- Content elements (Practical work)

Week(s)	Chapters/Content Items	No. HR	Goals

1	*Principle of operation of RFID.*	*1.5*	*OBJ 1*
2	*Classifications of RFID systems.*	*1.5*	*OBJ 1*
3-4	*Mode of operation of passive RFID tags, Inductively coupled RFID systems.*	*3*	*OBJ 1*
5	*Regulation and Standardization.*	*1.5*	*OBJ 2*
6-7	*Design of the antennas giving their geometric dimensions and expected performances: dipole antenna and monopoly antenna.*	*3*	*OBJ 2*
8-9	*The main performances of an antenna: radiation pattern, directivity, gain, etc.*	*3*	*OBJ 3*
10-11	*Design of the antennas giving their geometric dimensions and expected performances: patch antenna.*	*3*	*OBJ 3*
12	*Adaptation of the constituent components of an integrated RFID antenna.*	*1h30*	*OBJ 4*
13	*Communication principles: Coding and modulations of signals, uplink and downlink.*	*1h30*	*OBJ 4*
14	*Collision management: Deterministic algorithms and probabilistic algorithms.*	*1h30*	*OBJ 5*

3- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	x *No*	*20%*
DS - Supervised Duty	☐ *Yes*	
EE - Written test (Final exam)	☐ *Yes*	
EP - Practical test (TP - TP exam)	☐ *Yes*	*80%*

- *TP material : Average = 20% CC + 80% EP*

4- Evaluation criteria

- *Authorized documents : X No*
- *Authorized search engine : x No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

5- Web references (useful links):

- *www.biruni.tn*

. RFID : Radio Frequency Identification

Rieback, M. R., van Drongelen, J., & Tanenbaum, A. S. (2008). RFID Security and Privacy: A Research Survey. Springer.

Finkenzeller, K. (2010). RFID Handbook: Fundamentals and Applications in Contactless Smart Cards and Identification (2nd ed.). Wiley.

6- Working environment (Facilities necessary for learning)

- *Altair FEKO electromagnetic simulation tool version 2020.*

Course Specification

Industry 4.0

1.General

Coded	*ELEC-SE 5 109*	Level/Semester	*3/S5*	Coefficient	1.5	Credits	2
Course	*Industrial Engineering*					Volume. H. (CI)	*21*
Responsible	*Mounir FRIJA*					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*29*
Module	Industry 4.0					Version	*09/2023*

Course description (Course objective):
In this course you will see a specialization overview, learn what Industry 4.0 is all about, learn about the enabling factors that made it, and become aware of what key skills to learn to be employed in the industry 4.0 market segment.

Prerequisites:	*Keywords:*
- Information system - The basics of production management - basic knowledge in electronics - basic knowledge in IT	

Specific objectives of the course (OBJ):
OBJ 1 : Describe the key concepts of Industry 4.0 ***OBJ 2 :*** List the core elements of i4.0 ***OBJ 3 :*** Being Able to Apply i4.0 concepts to a manufacturing environment

Necessary material:
- ***None***

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals

1-4	***Chapter 1:*** Overview industry 4.0	*3*	- The Evolution of Industry from 1.0 to 4.0 - Use cases: smart factory. - Benefits of Adopting an Industry 4.0 Model - Vertical and horizontal integration
5 -8	***Chapter 2:*** CPS & IT tools	6	- Overview CPS - IIOT & CLOUD - MY - ERP - CRM
9-11	***Chapter 3:*** Management 4.0	*6*	- Change Management for Industry 4.0
12-14	***Chapter 4:*** Competence for Industry 4.0	*6*	- Lean 4.0 - Worker 4.0

3- Content elements (Practical work)

Week(s)	Activities/Content Elements	No. HR	Goals

...	...	...	...
...	...	...	...
12	*Practical exam, mini-project defense, ...*	*3h*	*Summative evaluation*

4- Evaluation methods & Marks Distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☒*No*	*20%*
DS - Supervised Duty	☐ *Yes* ☒*No*	*20%*
EE - Written test (Final exam)	☐ *Yes* ☒*No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☒*Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes ☒No*
- *Authorized search engine : ☐ Yes ☐ No*
- *Criterion 1: Understanding of the content (4 points)*
- *Criterion 2: Application of knowledge (10 points)*
- *Criterion 3: Critical analysis (4 points)*
- *Criterion 4: Clarity and organization (2 points)*
- *)*

6- Web references (useful links):

. odoo.com

Brettel, M., Friederichsen, N., Keller, M., & Rosenberg, M. (2014). How virtualization, decentralization and network building change the manufacturing landscape: An Industry 4.0 perspective. International Journal of Mechanical, Industrial Science and Engineering, 8(1), 37-44.

Lasi, H., Fettke, P., Kemper, H. G., & Feld, T. (2014). Industry 4.0. Business & Information Systems Engineering, 6(4), 239-242.

7- Working environment (Facilities necessary for learning)

- *Industry 4.0 laboratory , computer laboratory*

Course Specification

Quality Management

1. General

Coded	ELEC-SE 5 110	Level/Semester	3/S5	Coefficient	1.5	Credits	2
Course	Electrical Engineering					Volume. H. (CI)	21
Responsible	Mrs Maisa Chaibi					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions					Self study H.	29
Module	Quality Management					Version	09/2023

Course description (Course objective):
The main objective of the "Quality Management" subject is to ensure and enhance the quality of an organization's products or services. This involves the establishment of systems and processes aimed at ensuring that products or services meet customer standards and expectations. In summary, quality management aims to create an organizational culture focused on continuous improvement, customer satisfaction, and compliance with quality standards, all with the goal of ensuring the long-term competitiveness and sustainability of the organization in the market.

Prérequis :	*Mots clés :*
Business Organization, Management	*Quality, Process, certification, ISO, Audit, control*

Objectifs spécifiques du cours (OBJ$_i$) :

OBJ 1 : *Understanding Basic Principles: Acquire an in-depth knowledge of the fundamental principles of quality management, including basic concepts such as customer satisfaction, continuous improvement, and compliance with standards.*

OBJ 2 : *Application of Methodologies: Be able to apply specific quality management methodologies, such as Total Quality Management (TQM), Six Sigma, or other relevant approaches.*

OBJ 3 : *Process Analysis: Develop skills to analyze organizational processes, identify potential weaknesses, and propose improvements to increase efficiency and quality.*

OBJ 4 : *Knowledge of International Standards: Familiarize oneself with international quality standards, such as ISO 9001, and understand how they can be implemented within an organization.*

OBJ 5 : *Total Quality Management: Understand concepts related to total quality management, including the involvement of all members of the organization in continuous improvement.*

OBJ 6 : *Use of Quality Management Tools: Master the use of specific tools such as control charts, Pareto charts, Ishikawa diagrams, etc., for data collection and analysis.*

OBJ 7 : *Implementation of Management Systems: Be able to implement quality management systems within an organization, including the development of suitable policies and procedures.*

OBJ 8 :	*Risk Assessment: Learn to identify, assess, and manage risks related to the quality of products or services. …*

Matériel nécessaire :
Video projector

2- Eléments de contenu (Cours)

Semaine(s)	Chapitres/Eléments de contenu	Nbr. HR	Objectif(s) visés
1	***Introduction***	*1h30*	-Introducing quality management to students provides practical and strategic preparation for their future professional careers while developing skills that are increasingly sought after in the job market. It also contributes to promoting a culture of quality and continuous improvement in various sectors of activity.
2	**Chapter 1: Total Quality Management (TQM) :** **Introduction to TQM:** An overview of the fundamental principles of Total Quality Management, including its significance in continuous quality improvement. **Philosophy and Principles of TQM:** Exploration of TQM guiding principles, such as customer focus, involvement of all organization members, continuous improvement, and data-driven decision-making. **Voice of the Customer (VOC):** Understanding how to listen to and comprehend customer needs and expectations, and how to integrate this information into decision-making processes.	*1h30*	--Gain a thorough understanding of the fundamental principles of Total Quality Management (TQM) and its role in quality management. Be able to apply TQM guiding principles, such as customer focus, involvement of organization members, continuous improvement, and data-driven decision-making, in real-world scenarios. -Develop the skill to carefully listen to the Voice of the Customer, understand their needs and expectations, and

			strategically integrate this information.
3-4	**Quality Planning:** Strategic and operational planning processes necessary to integrate quality objectives throughout the organization. **Process Management:** How TQM aims to manage processes holistically, identifying and eliminating sources of variation that could affect quality. **Leadership Commitment:** The importance of leadership commitment and engagement in the successful implementation of TQM. **Training and Employee Involvement:** How TQM encourages ongoing training and involvement of all staff members to achieve quality goals.	*3H*	-Master the processes of strategic and operational planning necessary to effectively integrate quality objectives throughout the organization. -Develop skills in holistic process management, identifying and eliminating variations that could impact the quality of products or services. -Recognize the importance of committed leadership for the success of TQM implementation, emphasizing the crucial role of leadership in driving change. -Encourage continuous involvement of all staff members in the quality improvement process and foster a culture of continuous learning.
5	**Performance Measurement:** The use of performance indicators and metrics to assess and improve process quality. **Continuous Improvement:** How TQM fosters a culture of continuous improvement, including the use of cycles such as the PDCA (Plan-Do-Check-Act) cycle. **Quality Assurance Systems:** How TQM can be integrated into formal quality assurance systems to ensure compliance with standards and expectations.	*1h30*	-Be able to use performance indicators and metrics to assess, monitor, and improve the quality of organizational processes. -Develop the ability to create and support an organizational culture that promotes continuous improvement, including the use of cycles like PDCA. -Understand how TQM can be integrated into formal quality assurance systems to ensure compliance with standards and expectations.

6-7	**Chapter 2. Méthodes et outils qualité** Introduction to Quality Methods and Tools: Definition of basic concepts, objectives, and the importance of quality methods and tools in quality management. **Statistical Methods:** Utilization of statistical methods such as control charts, trend analyses, distributions, and sampling methods to assess and enhance quality. **Six Sigma:** Understanding the principles of Six Sigma, a structured approach aimed at reducing process variability and improving quality.	3H	-Define and comprehend basic concepts, objectives, and the significance of quality methods and tools in quality management. -Master statistical methods, including control charts, trend analyses, distributions, and sampling techniques, for quality assessment. -Gain a comprehensive understanding of Six Sigma principles as a structured approach to reducing process variability and improving quality. -Advocate and promote a culture of quality within the organization, emphasizing continuous improvement and the strategic use of quality methods. -Apply quality methods and tools to optimize organizational processes, focusing on efficiency, effectiveness, and the delivery of high-quality products or services.
8	**PDCA (Plan-Do-Check-Act):** Application of the PDCA cycle, a continuous improvement methodology involving planning, implementing, evaluating, and adjusting processes. **FMEA (Failure Modes and Effects Analysis):** Employing FMEA to identify, assess, and mitigate potential risks in processes and products.	1h30	-Apply the PDCA cycle with precision, demonstrating proficiency in each phase—planning, implementing, evaluating, and adjusting processes. -Integrate PDCA as a continuous improvement methodology into organizational practices to enhance overall efficiency and effectiveness. -Utilize FMEA as a systematic approach to identify, assess, and mitigate potential risks

			associated with processes and products. -Apply FMEA techniques to prioritize and address failure modes, ensuring a proactive approach to risk management.
9	**Problem-Solving Methods:** Application of structured problem-solving methods such as the 8D (8 Disciplines) approach to address quality issues systematically. **Quality Management Tools:** Utilization of specific tools such as Pareto charts, Ishikawa diagrams (or fishbone diagrams), control charts, and others to analyze and visualize quality data.	*1h30*	-Apply structured problem-solving methods, specifically the 8D (8 Disciplines) approach, systematically addressing quality issues. -Demonstrate mastery in each discipline of the 8D approach to ensure comprehensive problem resolution. -Apply problem-solving methods and quality tools in practical quality scenarios, demonstrating adaptability and effectiveness in various contexts. -Solve real-world quality issues using a combination of problem-solving methodologies and relevant tools.
10-11	**Chapter 3. Statistical Process Control (SPC**) **Introduction to Statistical Process Control** (SPC): **Definition of SPC** and its role in quality management. Significance of SPC in monitoring and continuous improvement of processes. **Fundamental Principles of SPC**: Basic concepts such as variation, process stability, and types of data. **Types of Statistical Controls:** Control charts for variables and attributes.	3h	Certainly, here are the objectives formulated in English based on the provided content: - Develop a thorough understanding of the fundamental principles of SPC, including concepts of variation, process stability, and types of data.

	Utilization of graphs and tables for visualizing data. Data Collection for SPC:		- Acquire skills in the practical application of statistical control techniques, including the use of control charts for variables and attributes. - Be capable of critically interpreting patterns on control charts, including identifying trends, outliers, and signals of variation.
12	**Methods of data collection**, sampling frequency, and techniques to ensure the representativeness of samples. **Analysis of Control Charts**: Interpretation of patterns on control charts, including trends, outliers, and signals of variation.	1h30	Master data collection methods, sampling frequency, and techniques ensuring the representativeness of samples in the context of SPC.
13-14	**Calculation of Control Limits**: Methods for determining upper and lower control limits based on process characteristics. **Process Stability**: Methods for assessing the stability of a process using SPC. Identification of special and common sources of variation. **Utilization of SPC for Continuous Improvement**: How SPC can be integrated into a continuous improvement approach, including PDCA (Plan-Do-Check-Act).	3h	Develop the necessary skills to calculate upper and lower control limits based on specific process characteristics. - Learn to assess the stability of a process using specific SPC methods and identify sources of special and common variation. - Understand how to integrate SPC into a comprehensive approach to continuous improvement, implementing cycles such as PDCA (Plan-Do-Check-Act).

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
...	...	...	...
...	...	...	...
12	*Practical exam, mini-project defense, ...*	*3h*	*Summative evaluation*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	■ *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	■ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents* : ☐ *Yes* ■ *No*
- *Authorized search engine* : ☐ *Yes* ■ *No*
    - *Criterion 1: Understanding of the content (4 points)*
    - *Criterion 2: Application of knowledge (10 points)*
    - *Criterion 3: Critical analysis (4 points)*
    - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

1. David L. Goetsch, Stanley Davis, "Quality Management for Organizational Excellence: Introduction to Total Quality", Edition: 8th Edition

2. Joseph M. Juran, Joseph A. DeFeo, "Juran's Quality Handbook: The Complete Guide to Performance Excellence",7th Edition

3. Nancy R. Tague , "The Quality Toolbox", 2nd Edition

4. Mary Pellettieri, Christopher Swersey, "Quality Management: Essential Planning for Breweries", 1st Edition

5. Mikel J. Harry, Richard Schroeder, "Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations", 1st Edition

6. Jeffrey K. Liker , "The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer", Édition: Revised

7- Environnement de travail (Installations nécessaires à l'apprentissage)

- *Intitulé, Version, URL*
- *…*

5th Year Industrial Control Major: S5

Course Specification

Control of electrical machines

1. General

Coded	*ELEC - CI 5 101*	Level/Semester	*3/S5*	Coefficient	*3*	Credits	*3*
Course	*Electrical engineering*					Volume. H. (CI)	*21*
Responsible	*Mrs Nadia Hajji*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*40*
Module	*Control of electrical machines*					Version	*09/2023*

Course description (Course objective):
Allow the student to acquire knowledge in the field of intelligent controls of the most used electrical machines: (direct current machine, three-phase asynchronous machine, synchronous machine, etc.) and to manipulate them according to the requirements of the system studied while guaranteeing better performance (speed, precision and stability).

Prerequisites:	*Keywords :*
Electrotechnics, static converters, electrical machines, modeling of electrical machines, automation.	*Direct current machines, asynchronous machines, synchronous machines, converters…*

Specific objectives of the course (OBJ):
OBJ 1 : *Understand speed variation techniques and choose the suitable converter for each machine (operating quadrant, supply voltage).* ***OBJ 2 :*** *Understand the control techniques that make it possible to influence the performance of the controlled system.*

Necessary material :
Electrical machines: Direct current machine, asynchronous machine, synchronous machine, speed variators, computer.

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-4	*DC machine control*	*6*	*Study speed variation techniques, study suitable converters depending on the power supply,*

			study the performance of a system driven by an MCC (speed control, current control, etc.)
5-9	*Control of the asynchronous machine*	*7.5*	*- Scalar control of the asynchronous machine* *-Vector control of the asynchronous machine*
10-14	*Synchronous machine control*	*7.5*	*- Scalar control of the synchronous machine* *-Vector control of the synchronous machine*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
3	*Separately Excited/Shunt DC Machine Control*	*3h*	*-Model and study the operation of a direct current motor at variable speed by simulating then interpreting the operating curves.* *-Analyze the operation of direct current machines under load, in open loop and closed loop.* *-Analyze and interpret the machine's response.*
6	*Control of the asynchronous machine*	*3h*	*- Model and study the operation of an asynchronous motor in variable speed by simulating then interpreting the operating curves.* *- Design a speed variator* *- Understand the components of a speed variator* *- Analyze the performance of the asynchronous machine.*
9	*Control of the asynchronous machine*	*3h*	*Model and study the operation of a synchronous machine in variable speed by simulating then interpreting the operating curves.* *-Study of the alternator under load* *Study of the stability of synchronous machines*
12	*Practical exam, mini-project defense, …*	*1h30*	*Summative evaluation*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC – Continuous assessment (Test/Quiz, Presentation, Report, etc.)	x *Yes* ☐ *No*	
DS – Supervised Duty	x *Yes* ☐ *No*	

EE – Written test (Final exam)	x *Yes* ☐ *No*	
EP – Practical test (TP- TP exam / MP- Mini project)	x *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes x No*
- *Authorized search engine : ☐ Yes x No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *Jean-Paul Hautier , Modeling and control of the asynchronous machine, Edition Technip, 1995.*
- *Michel Pinard , Electronic control of machines, Cahiers Collection techniques , Edition Dunod, 2013.*
- *Boldea, I., & Nasar, S. A. (2010). Electric Machines and Drives (2nd ed.). CRC Press.*
- *Bimal, K. B. (2014). Control of Electric Machine Drives (1st ed.). Oxford University Press.*

7- Working environment (Facilities necessary for learning)

- *Title, Version, URL*
- *…*

Course Specification

Design office

1. General

Coded	*EIEC - CI 5 102*	Level/Semester	*3/S5*	Coefficient	*1.5*	Credits	*2*
Course	*electrical engineering*					Volume. H. (CI)	
Responsible	*Mrs Imen Kortas*					Volume. H. (TP)	*21*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*28*
Module	*Design office*					Version	*09/2023*

Course description (Course objective):
- *This course aims to establish the energy balance of an electrical installation according to given specifications, size the electrical equipment and establish single-line diagrams on AutoCad.*

Prerequisites:	*Keywords :*
Knowledge of basic concepts of electrical diagrams.	*Single-line diagram, power balance, electrical equipment, neutral system, etc.*

Specific objectives of the course (OBJ):
OBJ 1: Initialization to AutoCad. OBJ 2: Sizing an electrical installation. OBJ 3 : Establish single-line diagrams of an electrical installation.

Necessary material :
Computer station, AutoCad

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
1-2	TP 1-2: Introduction to the AutoCAD environment: Institutions / Commands / Functions	*4.5*	Become familiar with the functions on AutoCad.

3-4	TP 3-4: Creation of lighting plans & electrical connections (power/telephone & computer sockets).	*4.5*	*Establish the architectural and single-line diagram of an example of electrical installation*
5	TP5: Sizing of protection devices & calculation of cable sections.	*6*	*Establish the power balance and choice of equipment.*
6	TP 6: Study of earthing systems.	*6*	*Choice of neutral regime depending on the nature of the environment.*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	■ *Yes* ☐ *No*	*20%*
DS - Supervised Duty	☐ *Yes* ☐ *No*	
EE - Written test (Final exam)	☐ *Yes* ☐ *No*	
EP - Practical test (TP- TP exam / MP- Mini project)	■ *Yes* ☐ *No*	*80%*

- ***Material 100% TP : Average = 20% CC + 80% EP***
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes ■ No*
    - *Criterion 1: Understanding of the content (4 points)*
    - *Criterion 2: Application of knowledge (10 points)*
    - *Criterion 3: Critical analysis (4 points)*
    - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

AUTOCAD ELECTRICAL TOOLSET

https://www.ftz.fr/

Ulrich, K. T., & Eppinger, S. D. (2015). Product Design and Development (6th ed.). McGraw-Hill Education.

Pahl, G., Beitz, W., Feldhusen, J., & Grote, K. H. (2007). Engineering Design: A Systematic Approach (3rd ed.). Springer.

7- Working environment (Facilities necessary for learning)

- *None*

Course Specification

Industry 4.0

1.General

Coded	*ELEC-SE 5 109*	Level/Semester	*3/S5*	Coefficient	1.5	Credits	2
Course	*Electrical engineering*					Volume. H. (CI)	*21*
Responsible	*Mounir FRIJA*					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*29*
Module	Industry 4.0					Version	*09/2023*

Course description (Course objective):
In this course you will see a specialization overview, learn what Industry 4.0 is all about, learn about the enabling factors that made it, and become aware of what key skills to learn to be employed in the industry 4.0 market segment.

Prerequisites:	*Keywords:*
- Information system - The basics of production management - basic knowledge in electronics - basic knowledge in IT	

Specific objectives of the course (OBJ):
OBJ 1 : Describe the key concepts of Industry 4.0 ***OBJ 2 :*** List the core elements of i4.0 ***OBJ 3 :*** Being Able to Apply i4.0 concepts to a manufacturing environment

Necessary material:
- ***O***

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals

1-4	***Chapter 1:*** Overview industry 4.0	*3*	- The Evolution of Industry from 1.0 to 4.0 - Use cases: smart factory. - Benefits of Adopting an Industry 4.0 Model - Vertical and horizontal integration
5 -8	***Chapter 2:*** CPS & IT tools	6	- Overview CPS - IIOT & CLOUD - MY - ERP - CRM
9-11	***Chapter 3:*** Management 4.0	*6*	- Change Management for Industry 4.0
12-14	***Chapter 4:*** Competence for Industry 4.0	*6*	- Lean 4.0 - Worker 4.0

3- Content elements (Practical work)

Week(s)	Activities/Content Elements	No. HR	Goals

...	...	...	...
...	...	...	...
12	*Practical exam, mini-project defense, ...*	*3h*	*Summative evaluation*

4- Evaluation methods & Marks Distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☒*No*	*20%*
DS - Supervised Duty	☐ *Yes* ☒*No*	*20%*
EE - Written test (Final exam)	☐ *Yes* ☒*No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☒*Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes ☒No*
- *Authorized search engine : ☐ Yes ☐ No*
- *Criterion 1: Understanding of the content (4 points)*
- *Criterion 2: Application of knowledge (10 points)*
- *Criterion 3: Critical analysis (4 points)*
- *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

1. odoo.com
2. Brettel, M., Friederichsen, N., Keller, M., & Rosenberg, M. (2014). How virtualization, decentralization and network building change the manufacturing landscape: An Industry 4.0 perspective. International Journal of Mechanical, Industrial Science and Engineering, 8(1), 37-44.
3. Lasi, H., Fettke, P., Kemper, H. G., & Feld, T. (2014). Industry 4.0. Business & Information Systems Engineering, 6(4), 239-242.

7- Working environment (Facilities necessary for learning)

- *Industry 4.0 laboratory , computer laboratory*

Course Specification

Industrial maintenance techniques

1. General

Coded	*ELEC-CI 5 104*	Level/Semester	*1*	Coefficient	*3*	Credits	*3*
Course	*Electrical Engineering*					Volume. H. (CI)	*31.5*
Responsible	*Mr Mouldi Ghdir*					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*40*
Module	Industrial maintenance techniques					Version	*09/2023*

Course description (Course objective):
- Be able to diagnose and repair electrical installations and systems -To choose the technique and the diagnostic method

Prerequisites:	*Keywords :*
- Electrotechnics, electrical diagram and standard , equipment and safety electric ……..	

Specific objectives of the course (OBJ):
OBJ 1 : *Know the different forms of maintenance (preventive, curative, conditional, etc.)* ***OBJ 2 :*** *Know maintenance methods* ***OBJ 3 :*** *Development of the maintenance procedure*

Necessary material :
…

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	***CHI: Maintenance strategy:*** *the functions of maintenance (documentation, preparation, execution and management)* *Preventive, curative, conditional maintenance: definition of advantage and disadvantage. Method of systematic preventive maintenance, curative, conditional, etc.* *Method of diagnosing a breakdown, Choice of type of maintenance*	*4h30*	*OBJ 1*
3-4	***CHI: Maintenance strategy:*** *the functions of maintenance (documentation, preparation, execution and management)*	*4h30*	*OBJ 1*

	Preventive, curative, conditional maintenance: definition of advantage and disadvantage. Method of systematic preventive maintenance, curative, conditional, etc.		
5-6	***CHII: Electrical standards and safety** : regulatory standards (CEI, CENELEC, UTE, etc.) definition of electrical risks, causes of accidents, effect of contained and alternating current, protection against direct and indirect contact.*	*4h30*	*OBJ 2*
7-8	***CHIII: Study of electrical installations:** Identification of the Type of installation TN, IT, TT, Field of application, Representation of the fault circuit, safety study for each installation calculation of fault current and contact voltage*	*4h30*	*OBJ 2*
9-10	*Physiological effect Choice of protection devices: Thermal-magnetic circuit breaker, RCD, fuse, disconnector, thermal relay, magnetic relay, etc. Electrical measuring and detection devices: Multimeter, oscilloscope, leakage current and earth tester*	*4h30*	*OBJ 2*
11-12	***CH IV:** Generator: Operating principle, presentation of the synoptic diagram, description of the components, systematic preventive maintenance, curative maintenance with presentation of some breakdown with possible causes and solutions, quality control and checklist of the generator*	*4h30*	*OBJ 3*
13-14	***CHV** : **Rotating machines** : Application: synchronous machine and generator motor Functional and material decomposition, application of FMEA for the study of some components of the motor and the synchronous machine, determination of the criticality and the corresponding maintenance action (preventive, curative, etc.)*	*4h30*	*OBJ 3*

3- Content elements (Practical work)

Week(s)	Activities/Content Elements	No. HR	Goals
		…	…
		…	…
		3h	*Summative evaluation*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	X *Yes* ☐ *No*	*40%*

EE - Written test (Final exam)	X *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes ☐ No*
- *Authorized search engine : ☐ Yes ☐ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Industrial Safety - an overview Industrial Safety and Risk Management

Mobley, R. K. (2002). An Introduction to Predictive Maintenance (2nd ed.). Elsevier.

Tennessee, L. (2018). Maintenance Engineering Handbook (8th ed.). McGraw-Hill.

7- Working environment (Facilities necessary for learning)

- *Title, Version, URL*
- *…*

Course Specification

Diagnosis and functional safety

1. General

Coded	ELEC-CI 5 105	Level/Semester	3/S5	Coefficient	1.5	Credits	2
Course	*Electrical Engineering*					Volume. H. (CI)	21
Responsible	*Mr Mouldi Ghdir*					Volume. H. (TP)	10.5
Teaching methods	Lecture, interactive, direct instructions,Project Based					Self study H.	15
Module	Diagnosis and functional safety .					Version	09/2023

Course description (Course objective):
- Understand the diagnostic methods of industrial systems as well as the concepts and operational safety analysis methods -Study of an industrial system : functional composition , modeling and identification of FMDS parameters for the purpose of carrying out corrective and preventive actions

Prerequisites:	*Keywords :*
- Mathematics , maintenance, IT, automatic modeling	*Safety ,Diagnostic*

Specific objectives of the course (OBJ):
OBJ 1: *Know the qualitative and quantitative diagnostic methods of an industrial system*
OBJ 2: *Know the FMDS operational safety indicators*
OBJ 3 : *Study of an industrial system: functional decomposition, modeling, calculation of FMDS parameters in order to improve the reliability and availability of the system and to carry out corrective or preventive action*
OBJ 4 : *Diagnosis of system failure with a practical example using the appropriate method (fault tree, reliability diagram, Markov chain, etc.)*

Necessary material :
…

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	***CHI: Industrial diagnostics*** *: definition, classification of failures, decomposition of the functional and hardware system, model-based*	*3h*	*OBJ 1*

	and model-free diagnostic method, fault tree, reliability diagram, Markov chain petri net, expert system, logical neural network blur etc.,		
3-4	***CHII: Operational safety** : definition, FMDS, modeling of a system by the exponential law and Weibull law, calculation of parameters R, MTBF, MTTR, λ, μ, estimation of lifespan of a system* *Forecast reliability, Operational reliability*	*3h*	*OBJ 2*
5-6	***CHII: Reliability diagram**: reliability analysis of a serial system, parallel system, mixed parallel series and parallel series, with active and passive redundancy* *Study of a real system: representation of the reliability diagram, calculation of reliability, maintainability and availability,*	*3h*	*OBJ 2*
7-8	***CHIII: Fault tree** : definition, preliminary approach to developing the fault tree, basic principle of events, logical operators, stages of the fault tree: Application: identification of a failure at level an electrical installation, a lubrication system, generator*	*3h*	*OBJ 3*
9-10	***CH iv: FMEA** : definition, amdec production, amdec design, amdec equipment, critical, qualitative, quantitative approach and participatory approach. The stages of FMEA* *Definition of amdec parameters (C,F,D,G)* *Application: Machine tool lubrication system* *Analysis of their failure mode, their effect and their criticality*	*3h*	*OBJ 3*
11-12	***CHv:** State transition models Markov chain: definition, state equation, transition matrix, representation of system states, calculation of system availability* *Application: serial and parallel system, calculation of system availability, production rate, etc.*	*3h*	*OBJ 3- OBJ 4*
13-14	***CHVI: Transition state models Petrie network** : definition, reminder on the Petrie network,* *modeling the normal functioning of a system* *system failure modeling* *preventive maintenance modeling* *corrective maintenance modeling*	*3h*	*OBJ 4*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
6	***Reliability diagram***	*3h*	*OBJ 2*
12	*State transition models Markov chain*	*3h*	*OBJ 3*
13	***Transition state models Petrie network***	*3h*	*OBJ 4*
14	***evaluation***	*1h30*	*Summative evaluation*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	X *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	X *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents* : ☐ *Yes* ☐ *No*
- *Authorized search engine* : ☐ *Yes* ☐ *No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Safety diagnosis criteria - Development and testing
Safety diagnosis in industrial work settings

Hass, R., & Weyer, R. (2011). Functional Safety: A Straightforward Guide to Applying IEC 61508 and Related Standards. Springer.

Sung, H. Y., & Lee, J. H. (2018). Diagnosis and Prognosis of Systems with Applications to Industrial Maintenance. Wiley.

7- Working environment (Facilities necessary for learning)

- *Title, Version, URL*
- *...*

Course Specification

Machine Learning

1. General

Coded	*ELEC-CI 5 106*	Level/Semester	*3/S5*	Coefficient	*1.5*	Credits	*3*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*Mrs Ines Jaffel*					Volume. H. (TP)	*10.5*
Teaching methods	interactive, direct instructions,Project Based					Self study H.	*38*
Module	*Machine Learning*					Version	*09/2023*

Course description (Course objective):
This course aims to introduce the learning notion and its use for modelling and monitoring processes. The course details the main machine learning types. It emphasizes the problems of classification end regression and the database training. Finally It provides also some usual learning techniques.

Prerequisites:	*Keywords :*
Mathematics,	*SVM, the KNN, the KMEANS, Decision tree, ..*

Specific objectives of the course (OBJ):
***OBJ 1 :** Understand Machine Learning and know its main types (supervised, unsupervised, semi-supervised, etc.)* ***OBJ 2 :** Know the concepts, and understand the most used ML algorithms.* ***OB 3 :** Identifying problems and formalizing them in terms of Machine Learning.*

Necessary material :
…

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	***Introduction to Machine Learning (ML)*** - *Difference between ML and AI* - *Types of ML (supervised, unsupervised…)* - *Know the two problems posed mainly using ML (Classification/Regression)*	*3*	***OB 1***

3-4	- *Know how to train a Database* - *The limits of ML (quantity of data, calculation time, overfitting, etc.)* ***k-nearest neighbors method*** - *Principle (distance and similarity)* - *Lazy learning* - *Variant (Neighbor weighting)*	*3*	***OB1 & OB 2***
5	***Clustering by KMEANS method*** - *Principle* - *Lloyd's algorithm* - *Variant (KMEANS++)*	*3*	***OB 2***
6-7	***Decision Trees*** - *Definitions: Root node, Internal node, leaf, branch* - *Binary decision tree*	*3*	***OB 2***
8-9	- *Construction (CART algorithm)* - *Simplified decision tree (Pruning...)* - *Random Forests (Random variation of observations, Random variation of data)*	*4.5*	***OB 2***
10-11	***Support vector machine*** - *The linearly separable case: Linear SVM* - *The non-linearly separable case: Kernel SVM*	*4.5*	***OB 2***

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
12	*Classification workshop by methods (KNN and KMEAN) using python*	*3*	***OB 2- OB 3***
13	*Classification workshop by methods (SVM and RANDOM-FOREST) using python*	*3*	***OB 2- OB 3***
14	*Practical problems in terms of Machine Learning and solving*	*4.5*	***OBJ 3***

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	

DS - Supervised Duty	X *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	X *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	X *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Evaluation criteria

- *Authorized documents : ☐ Yes ☐ No*
- *Authorized search engine : ☐ Yes ☐ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Deep Learning vs. Machine Learning: A Beginner's Guide

Support Vector Machine (SVM) Algorithm

K-Means Clustering Algorithm

Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press.

Murphy, K. P. (2012). Machine Learning: A Probabilistic Perspective. MIT Press.

7- Working environment (Facilities necessary for learning)

- *Title, Version, URL*
- *…*

Course Specification

Modeling and control of mechatronic systems

1. General

Coded	*ELEC - CI 5 107*	Level/Semester	*3/S5*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*Mr Maher Letaief*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*16*
Module	*Modeling and control of mechatronic systems*					Version	*09/2023*

Course description (Course objective):

<u>Course description:</u>

Mechatronics is a technology combining mechanics, electronics, computing and new information and communication technologies. The alliance of these different areas makes it possible to think about a product differently from its design to recycling and maintenance. The aim of mechatronics is to create increasingly intelligent components and solutions that communicate with each other, to meet customer demands for excellence and enable the deployment of the factory of the future.

<u>The objective of the course:</u>

The student must be able to:

- *Decompose a complex system using the functional chain approach;*
- *Model a complex system;*
- *Establish the knowledge model of a complex system;*
- *Study the behavior of a complex system;*
- *Design complex systems with the aim of increasing and/or optimizing their functionality and performance.*
- *Model and simulate the behavior of a complex system.*

Prerequisites:	*Keywords :*
combinatorial & sequential logic systems ; analysis of automated systems, computer programming.	*Mechatronic system, complex system, energy chain, information chain.*

Specific objectives of the course (OBJ):

OBJ 1 : *Master the notions of complex systems;*

OBJ 2 : *Decompose a complex system using the functional chain approach;*

OBJ 3 : *Establish the knowledge model in order to study the behavior of a complex system;*

OBJ 4 : *Establish and simulate the behavior model of a complex system;* ***OBJ 5 :*** *Design complex and multidisciplinary systems;* ***OBJ 6 :*** *Create a virtual prototype of a complex system.*

Necessary material :
Painting ; Video projector, computer laboratory.

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1	*Chapter 1: Introduction to mechatronics*	*1.5*	*Define mechatronics; the physical fields involved in mechatronics;* *Define the field of application of mechatronics.* *The objectives of mechatronic systems.*
2-3	*Chapter 2 : Structural constitution of a mechatronic system.*	*3*	*Describe in a global way the functioning of a complex system;* *Identify and specify the exchange part PE, the control part PC and the operational part PO;* *Define the interactions between PE-PC-PO.*
4	*Tutorials Chapter2*	*1.5*	
5-6	*Chapter 3: Functional chain of a mechatronic system.*	*3*	*Describe the detailed operation of a complex system; Break down a complex system into an energy chain and an information chain; Know all the elements constituting the energy chain;*
7	*Assessment*	*1.5*	
8	*Continued Chapter 3: Functional chain of a mechatronic system.*	*1.5*	*Know all the elements constituting the information chain;*
9	*Tutorials for chapter 3*	*1.5*	
10-11-12	*Chapter 4: Modeling, simulation and coding of mechatronic systems.*	*4.5*	*Define the concept Energy-Power;* *Define effort-flow variables;*

			Define the basic models associated with mechanics, electrical, hydraulic… *Define energy resources;* *Model mechatronic systems* *Define the general principle for modeling a complex system;* *Define the knowledge model;* *Define the behavior model;*
13-14	*Chapter 4 tutorials*	*3h*	*Tutorials*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
5	*TP 1: Discover the Simulink environment.*	*1.5*	*Discover the Simulink interface for the design of complex systems.*
8	*TP 2: Preparation for mechatronic modeling of a complex system.*	*1.5*	*Based on a need defined by specifications, design a complex system;* *Apply the decomposition into PE-PC-PO;* *Create the energy chain and the information chain.*
10	*TP 3: Modeling and simulation of the behavior of the system created in TP2.*	*3*	*Develop the knowledge model of the energy chain;* *Carry out modeling of the energy chain;* *Simulate the system.*
12	*TP 4: Creation of a virtual prototype of the system developed in TP2 and TP3.*	*1.5*	*Create a prototype of a complex system;* *Validate the characteristics of the different components.*
13-14	*TP 5: Modeling and simulation of the behavior of a multiphysics system. (Apply the entire mechatronic approach).*	*3*	*Create the energy chain and the information chain;* *Develop the knowledge model of the energy chain;* *Carry out modeling of the energy chain;* *Simulate the system.*

			Create a prototype of a complex system; *Validate the characteristics of the different components.*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	x *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	x *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	x *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Evaluation criteria

- *Authorized documents : ☐ Yes x No*
- *Authorized search engine : ☐ Yes x No*
    - *Criterion 1: Understanding of the content (4 points)*
    - *Criterion 2: Application of knowledge (10 points)*
    - *Criterion 3: Critical analysis (4 points)*
    - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *R. Isermann, "Mechatronic systems: concepts and applications," Transactions of the Institute of Measurement and Control, vol. 22, 2000 , p. 29-55*
- *Abdelwahab MAHDHI, "Mechatronic systems from modeling to simulation", University Publication Center, 2018. 184 p.*
- *Lionel Birglen, Méchatronique, Dunod, 2008. (ISBN 9782100744787,*
- *Mechatronics: monitoring notes and application examples (CETIM)*
- *"SimFonIA Animation Tools" a tool for animating mechatronic systems*

7- Working environment (Facilities necessary for learning)

- *None*

Course Specification

Production Analysis & Management

1. General

Coded	*ELEC - CI 5 108*	Level/Semester	*3/S5*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Option	*Mr Habib Abdennaji*					Volume. H. (TP)	*0*
Teaching methods	Lecture, interactive, direct instructions,Project Based					Self study H.	*26*
Module	*Analysis & Production Management*					Version	*09/2023*

Course description (Course objective):
This course aims to improve the knowledge and skills of electrical engineers in the field of production organization and management. Participants will learn the fundamentals of production management, including planning, scheduling, controlling and improving manufacturing processes. They will also gain an in-depth understanding of the methods and tools used to optimize production efficiency and productivity.

Prerequisites:	*Keywords :*
Industrialization course	*Production management, Production scheduling, Planning*

Specific objectives of the course (OBJ):
OBJ 1 : Understand the basic principles of production management **OBJ 2 :** Master the methods of planning and scheduling manufacturing processes **OBJ 3 :** Learn to control and improve production performance **OBJ 4 :** Apply the concepts learned to real production cases

Necessary material :
…

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-3	Introduction to production management • Basic concepts of production management • Roles and responsibilities of the production manager • Typology of production systems and implementation methods • Principles of production optimization	*4.5*	Understand the basic principles of production management

	• Analysis of a production process and proposal for improvements		
4-9	Detailed Planning • Calculation of Net Needs (MRP0) • Capacity study and production regulation (MRP1) • Scheduling technique (MRP2)	*9*	Master manufacturing process planning methods
10-14	Production control and improvement • Measuring and monitoring production performance • Continuous improvement methods (JIT) • Management of production problems • Analysis of production data and proposal of improvement solutions • Case study	*7.5*	Learn to control and improve production performance and Apply the concepts learned to real cases.

3- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes ☒ No*
- *Authorized search engine : ☐ Yes ☒ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- Brissard, JL and Polizzi, M. Tools for industrial production management, Afnor-gestion;
- Zermati, P. Practice of inventory management. Dunod;
- Heizer, J., Render, B., & Munson, C. (2017). Operations Management: Sustainability and Supply Chain Management (12th ed.). Pearson.

- Stevenson, W. J. (2018). Operations Management (13th ed.). McGraw-Hill Education.Vallet, G. Project planning techniques. Dunod, Paris.
- Beranger, P. The new rules of production, Dunod;
- Milan, A. Jouve, M. Communication and business organization. Collection - Breal.
- Engineering Techniques, Safety / prevention of industrial risks, AG 4- April 2004;
- COURTOIS A., MARTIN-BONNEFOUS C., PILLET M. Production management Éditions d'organization – 4th edition – 2006
- GEORGES Javel, Organization and Management of Production, Dunod, Paris, 2004;
- Alain Courtois, Maurice Pillet, Chantal Martin-Bouneffous, Production Management, organizational edition 2003.
- Operations Management" by Jay Heizer, Barry Render (2016)
- Production and Operations Analysis" by Steven Nahmias (2015)

Course Specification

Renewable Energies

1. General

Coded	*ELEC-CI 5 109*	Level/Semester	*3/S5*	Coefficient	*3*	Credits	*3*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*Mrs Janet Jamii*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*38*
Module	*Renewable Energies*					Version	*09/2023*

Course description (Course objective):
• **Photovoltaic** : -Photovoltaic System Modeling: In-depth study of the components, electrical characteristics and mathematical models that describe the operation of a photovoltaic system. -MPPT control: Exploring techniques to maximize energy efficiency by maintaining the maximum power point of the photovoltaic system. • **Wind turbine** : -Wind System Modeling: Understanding the basic principles of modeling wind energy systems, including mechanical and electrical aspects. -Wind Mechanical Power MPPT: Study of methods for monitoring the maximum power point in the context of wind energy systems to optimize the conversion of mechanical energy into electricity. -Power Converters: Analysis of converters used to transform wind energy into a form suitable for the electricity grid. -Electric Machines: Overview of electrical machines, such as synchronous generators, used in wind energy systems. -Wind Systems Controls (Isolated and Interconnected): Isolated: Exploration of control strategies adapted to wind power systems operating on an isolated site, without connection to the main electricity network. -Interconnected: Study of the control techniques necessary to effectively integrate wind energy systems into interconnected electrical networks. • **Smart Grids** - Understanding the characteristics of smart power grids, highlighting advanced communications technologies, increased automation, and proactive energy management. -Interoperability: Importance of interoperability of devices and systems in Smart Grids to enable effective communication between different components. -Smart Meters: Exploring advanced features of smart meters, such as accurate measurement of energy consumption, two-way communication, and the ability to integrate real-time data into network management.

Prerequisites:	*Keywords :*

-Familiarity with different renewable energy sources, including solar, wind. *- Awareness of environmental issues and sustainable development principles.* *-Understanding of conventional electrical networks, their structure and their operation.* *- Understanding of the basic principles of automation and control, essential for the automated management of Smart Grids.*	*Energy, solar, wind, MPPT, smart grid*

Specific objectives of the course (OBJ):
OBJ 1: *Model the photovoltaic system and extract the MPPT* ***OBJ 2:*** *Model the wind system isolated and connected to the electricity network* ***OBJ 3:*** *Understand the smart grid structure*

Necessary material :
Computer

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	*General information on renewable energies (solar, wind, hydraulic, biomass, biogas, etc.)*	*3*	*Mention the different renewable sources*
3-4	*Modeling of the photovoltaic system*	*3*	*Model the PV system*
5-6	*MPPT control and PV system control*	*3*	*Extract the MPPT and check the PV system*
7-8	*Guarded duty*	*3*	
9-10	*Modeling of isolated and grid-connected wind energy systems*	*3*	*Model the wind system*
11-12	*Smart grid*	*3*	*Define smart grid architectures*
13-14	*Directed work*	*3*	

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals

1	*Modeling of the photovoltaic system and MPPT control of PV using MATLAB*	3	*View PV characteristic*
2	*Wind system modeling and MPPT control*	3	*Visualize wind turbine output*
3	*Modeling and control of wind energy system connected to the MATLAB/SIMILINK network*	4.5	*Visualize the synchronous turbine-generator-converter-network chain*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	☒ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	☒ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☒ *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Evaluation criteria

- *Authorized documents : ☐ Yes ☒ No*
- *Authorized search engine : ☐ Yes ☒ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Renewable energy – powering a safer future
Renewable energy | Types, Advantages, & Facts

Renewable Energy | Types, Forms & Sources Smart Grids, réseaux électriques intelligents

Boyle, G. (2012). Renewable Energy: Power for a Sustainable Future (3rd ed.). Oxford University Press.

Raghuvanshi, S. (2017). Renewable Energy Technologies: A Practical Guide for Beginners. Wiley.

7- Working environment (Facilities necessary for learning)

- *Title, Version, URL*

Course Specification

Quality Management

1. General

Coded	*ELEC-CI 5 110*	Level/Semester	*3/5*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*Mrs Maisa Chaibi*					Volume. H. (TP)	*0*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*29*
Module	Quality Management					Version	*09/2023*

Course description (Course objective):
The main objective of the "Quality Management" subject is to ensure and enhance the quality of an organization's products or services. This involves the establishment of systems and processes aimed at ensuring that products or services meet customer standards and expectations. In summary, quality management aims to create an organizational culture focused on continuous improvement, customer satisfaction, and compliance with quality standards, all with the goal of ensuring the long-term competitiveness and sustainability of the organization in the market.

Prerequisites:	*Keywords :*
Business Organization, Management	*Quality, Process, certification, ISO, Audit, control*

Specific objectives of the course (OBJ):

OBJ 1 : *Understanding Basic Principles: Acquire an in-depth knowledge of the fundamental principles of quality management, including basic concepts such as customer satisfaction, continuous improvement, and compliance with standards.*

OBJ 2 : *Application of Methodologies: Be able to apply specific quality management methodologies, such as Total Quality Management (TQM), Six Sigma, or other relevant approaches.*

OBJ 3 : *Process Analysis: Develop skills to analyze organizational processes, identify potential weaknesses, and propose improvements to increase efficiency and quality.*

OBJ 4 : *Knowledge of International Standards: Familiarize oneself with international quality standards, such as ISO 9001, and understand how they can be implemented within an organization.*

OBJ 5 : *Total Quality Management: Understand concepts related to total quality management, including the involvement of all members of the organization in continuous improvement.*

OBJ 6 : *Use of Quality Management Tools: Master the use of specific tools such as control charts, Pareto charts, Ishikawa diagrams, etc., for data collection and analysis.*

OBJ 7 : *Implementation of Management Systems: Be able to implement quality management systems within an organization, including the development of suitable policies and procedures.*

OBJ 8 :	*Risk Assessment: Learn to identify, assess, and manage risks related to the quality of products or services. …*

Necessary material :
video projector

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1	***Introduction***	*1h30*	-Introducing quality management to students provides practical and strategic preparation for their future professional careers while developing skills that are increasingly sought after in the job market. It also contributes to promoting a culture of quality and continuous improvement in various sectors of activity.
2	**Chapter 1: Total Quality Management (TQM) :** **Introduction to TQM:** An overview of the fundamental principles of Total Quality Management, including its significance in continuous quality improvement. **Philosophy and Principles of TQM:** Exploration of TQM guiding principles, such as customer focus, involvement of all organization members, continuous improvement, and data-driven decision-making. **Voice of the Customer (VOC):** Understanding how to listen to and understand customer needs and expectations, and how to integrate this information into decision-making processes.	*1h30*	--Gain a thorough understanding of the fundamental principles of Total Quality Management (TQM) and its role in quality management. Be able to apply TQM guiding principles, such as customer focus, involvement of organization members, continuous improvement, and data-driven decision-making, in real-world scenarios. -Develop the skill to carefully listen to the Voice of the Customer, understand their needs and expectations, and strategically integrate this information.
3-4	**Quality Planning:** Strategic and operational planning processes necessary to integrate quality objectives throughout the organization. **Process Management:** How TQM aims to manage processes holistically, identifying and		-Master the processes of strategic and operational planning necessary to effectively integrate quality objectives throughout the organization. -Develop skills in holistic process management, identifying and

	eliminating sources of variation that could affect quality. **Leadership Commitment:** The importance of leadership commitment and engagement in the successful implementation of TQM. **Training and Employee Involvement:** How TQM encourages ongoing training and involvement of all staff members to achieve quality goals.	*3H*	eliminating variations that could impact the quality of products or services. -Recognize the importance of committed leadership for the success of TQM implementation, emphasizing the crucial role of leadership in driving change. -Encourage continuous involvement of all staff members in the quality improvement process and foster a culture of continuous learning.
5	**Performance Measurement:** The use of performance indicators and metrics to assess and improve process quality. **Continuous Improvement:** How TQM fosters a culture of continuous improvement, including the use of cycles such as the PDCA (Plan-Do-Check-Act) cycle. **Quality Assurance Systems:** How TQM can be integrated into formal quality assurance systems to ensure compliance with standards and expectations.	*1h30*	-Be able to use performance indicators and metrics to assess, monitor, and improve the quality of organizational processes. -Develop the ability to create and support an organizational culture that promotes continuous improvement, including the use of cycles like PDCA. -Understand how TQM can be integrated into formal quality assurance systems to ensure compliance with standards and expectations.
6-7	**Chapter 2. Quality methods and tools** Introduction to Quality Methods and Tools: Definition of basic concepts, objectives, and the importance of quality methods and tools in quality management. **Statistical Methods:** Utilization of statistical methods such as control charts, trend analyses, distributions, and sampling methods to assess and enhance quality. **Six Sigma:** Understanding the principles of Six Sigma, a structured approach aimed at reducing process variability and improving quality.	*3H*	-Define and understand basic concepts, objectives, and the significance of quality methods and tools in quality management. -Master statistical methods, including control charts, trend analyses, distributions, and sampling techniques, for quality assessment. -Gain a comprehensive understanding of Six Sigma principles as a structured approach to reducing process variability and improving quality. -Advocate and promote a culture of quality within the organization, emphasizing continuous improvement and the strategic use of quality methods.

			-Apply quality methods and tools to optimize organizational processes, focusing on efficiency, effectiveness, and the delivery of high-quality products or services.
8	**PDCA (Plan-Do-Check-Act):** Application of the PDCA cycle, a continuous improvement methodology involving planning, implementing, evaluating, and adjusting processes. **FMEA (Failure Modes and Effects Analysis):** Employing FMEA to identify, assess, and mitigate potential risks in processes and products.	*1h30*	-Apply the PDCA cycle with precision, demonstrating proficiency in each phase—planning, implementing, evaluating, and adjusting processes. -Integrate PDCA as a continuous improvement methodology into organizational practices to enhance overall efficiency and effectiveness. -Utilize FMEA as a systematic approach to identify, assess, and mitigate potential risks associated with processes and products. -Apply FMEA techniques to prioritize and address failure modes, ensuring a proactive approach to risk management.
9	**Problem-Solving Methods:** Application of structured problem-solving methods such as the 8D (8 Disciplines) approach to address quality issues systematically. **Quality Management Tools:** Utilization of specific tools such as Pareto charts, Ishikawa diagrams (or fishbone diagrams), control charts, and others to analyze and visualize quality data.	*1h30*	-Apply structured problem-solving methods, specifically the 8D (8 Disciplines) approach, systematically addressing quality issues. -Demonstrate mastery in each discipline of the 8D approach to ensure comprehensive problem resolution. -Apply problem-solving methods and quality tools in practical quality scenarios, demonstrating adaptability and effectiveness in various contexts. -Solve real-world quality issues using a combination of problem-solving methodologies and relevant tools.

10-11	**Chapter 3. Statistical Process Control (SPC)** **Introduction to Statistical Process Control** (SPC): **Definition of SPC** and its role in quality management. Significance of SPC in monitoring and continuous improvement of processes. **Fundamental Principles of SPC** : Basic concepts such as variation, process stability, and types of data. **Types of Statistical Controls:** Control charts for variables and attributes. Use of graphs and tables for visualizing data. Data Collection for SPC:	3h	Certainly, here are the objectives formulated in English based on the provided content: - Develop a thorough understanding of the fundamental principles of SPC, including concepts of variation, process stability, and types of data. - Acquire skills in the practical application of statistical control techniques, including the use of control charts for variables and attributes. - Be capable of critically interpreting patterns on control charts, including identifying trends, outliers, and signals of variation.
12	**Methods of data collection** , sampling frequency, and techniques to ensure the representativeness of samples. **Analysis of Control Charts** : Interpretation of patterns on control charts, including trends, outliers, and signals of variation.	1h30	Master data collection methods, sampling frequency, and techniques ensuring the representativeness of samples in the context of SPC.
13-14	**Calculation of Control Limits** : Methods for determining upper and lower control limits based on process characteristics. **Process Stability** : Methods for assessing the stability of a process using SPC. Identification of special and common sources of variation. **Use of SPC for Continuous Improvement** : How SPC can be integrated into a continuous improvement approach, including PDCA (Plan-Do-Check-Act).	3h	Develop the necessary skills to calculate upper and lower control limits based on specific process characteristics. - Learn to assess the stability of a process using specific SPC methods and identify sources of special and common variation. - Understand how to integrate SPC into a comprehensive approach to continuous improvement, implementing cycles such as PDCA (Plan-Do-Check-Act).

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
…	…	…	…
…	…	…	…
12	*Practical exam, mini-project defense, …*	*3h*	*Summative evaluation*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	■ *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	■ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes ■ No*
- *Authorized search engine : ☐ Yes ■ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

1. David L. Goetsch, Stanley Davis, "Quality Management for Organizational Excellence: Introduction to Total Quality", Edition: 8th Edition

2. Joseph M. Juran, Joseph A. DeFeo, "Juran's Quality Handbook: The Complete Guide to Performance Excellence",7th Edition

3. Nancy R. Tague, "The Quality Toolbox", 2nd Edition

4. Mary Pellettieri, Christopher Swersey, "Quality Management: Essential Planning for Breweries", 1st Edition

5. Mikel J. Harry, Richard Schroeder, "Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations", 1st Edition

6. Jeffrey K. Liker, "The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer", Edition: Revised

7- Working environment (Facilities necessary for learning)

- *Title, Version, URL*
- *…*

5thYear Biomedical instruments

Major: S5

Course Specification

Equipment maintenance 2

1. General

Coded	*ELEC – IB 5 101*	Level/Semester	*3/S5*	Coefficient	*3*	Credits	*3*
Course	*Electrical Engineering*					Volume. H. (CI)	*31.5*
Responsible	*Mr Mouldi Ghdir*					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions,Project Based					Self study H.	*40*
Module	*Equipment maintenance 2*					Version	*09/2023*

Course description (Course objective):
- standards, security and protection of property at the operating theater level -Presentation of the operating theater equipment - Master anesthesia and dialysis equipment the operating principle, maintenance and quality control

Prerequisites:	*Keywords :*
- Anatomy physiology, Computer science ; electronic, mechanical , pneumatic	

Specific objectives of the course (OBJ):
OBJ 1: *The student knows the architectural standards at the operating theater level:* ***OBJ 2:*** *Standards and safety of property and personnel relating to electrical installation and equipment* ***OBJ 3:*** *Know the operating principle, safety, preventive maintenance and quality control of operating room and anesthesia equipment, as well as diagnostic methods and tools* ***OBJ 4:*** *ensure safety repair apply a maintenance policy and develop procedures for the maintenance of equipment and installations*

Necessary material :
…

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	*CHI: operating theater standards and safety: safety of the electrical installation, biomedical instrumentation and air handling unit*	*3*	*OBJ 1*
3-4	*CHII: operating room equipment: operating light, operating table, medical and electrical fluid supply arms, air handling unit, etc. :*	*3*	*OBJ 2*

	operating principle, synoptic diagram, safety, preventive maintenance and technical quality control		
5-6	*CHII: operating room equipment: operating light, operating table, fluid and electrical supply arms, air handling unit, etc. : operating principle, synoptic diagram, safety, preventive maintenance and technical quality control*	*3*	*OBJ 2- OBJ 3*
7-8	*CHIII: Sheave Respirator: anatomy physiology, mechanical basis of ventilation, ventilation techniques, operating principle, fluidic, pneumatic, mechanical synoptic diagram, control cards and computer system: description of the modules, preventive maintenance and control of technical quality.*	*4.5*	*OBJ 2- OBJ 3*
9-10	*CHv: Water treatment room and dialysis generator: anatomy physiology of renal failure, dialysis techniques, operating principle, fluidic, pneumatic, mechanical synoptic diagram, control cards and computer system of the treatment room water and dialysis machine: description of modules, preventive maintenance and technical quality control*	*4.5*	*OBJ 2- OBJ 3*
10-11	*CHv: Water treatment room and dialysis generator: anatomy physiology of renal failure, dialysis techniques, operating principle, fluidic, pneumatic, mechanical synoptic diagram,*	*4.5*	*OBJ 2- OBJ 3*
11-12	*Control cards and the computer system of the water treatment room and the dialysis machine: description of the modules, preventive maintenance and technical quality control*	*4.5*	*OBJ 2- OBJ 3*
13-14	*CHVI: Anesthesia ventilator: anatomy physiology, operating principle, fluidic, pneumatic, mechanical synoptic diagram, control cards and computer system: description of modules, preventive maintenance and technical quality control*	*4.5*	*OBJ 4*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
		…	…
		…	…

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	■ *Yes* ☐ *No*	
EE - Written test (Final exam)	■ *Yes* ☐ *No*	

EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes X No*
- *Authorized search engine : ☐ Yes X No*
    - *Criterion 1: Understanding of the content (4 points)*
    - *Criterion 2: Application of knowledge (10 points)*
    - *Criterion 3: Critical analysis (4 points)*
    - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Guide to Equipment Maintenance Management Equipment Maintenance: Goals, Types, Program Setup Equipment Maintenance Procedures Guide

Mobley, R. K. (2002). An Introduction to Predictive Maintenance (2nd ed.). Elsevier.

Smith, R. (2015). The Maintenance Management Framework: Models and Methods for Complex Systems Maintenance (2nd ed.). Springer.

7- Working environment (Facilities necessary for learning)

- *Title, Version, URL*
- *…*

Course Specification

Medical imaging techniques: CT, ultrasound and MRI

1. General

Coded	*ELEC – IB 5 102*	Level/Semester	*3/S5*	Coefficient	*3*	Credits	*3*
Course	Electrical Engineering					Volume. H. (CI)	*31.5*
Responsible	Mr Saif Mrad					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*40*
Module	*Medical Imaging Techniques 2*					Version	*09/2023*

Course description (Course objective):
Provide students with an in-depth understanding of the principles, technology, applications, and future directions of medical imaging techniques: CT (Computed Tomography), Ultrasound, and MRI (Magnetic Resonance Imaging), with a focus on their clinical relevance and biomedical instrumentation.

Prerequisites:	*Keywords :*
Power electronics, anatomy, biophysics	…

Specific objectives of the course (OBJ):
Obj 1 Understand the scientific and technical principles behind CT, Ultrasound, and MRI. **Obj 2** Explain the steps involved in image acquisition, processing, and interpretation for each modality. **Obj 3** Analyze the clinical applications and advantages of each imaging modality for specific diseases and conditions. **Obj 4** Assess the safety considerations, including radiation and magnetic field exposure, for each imaging technique. **Obj 5** Interpret and analyze medical images accurately for clinical diagnosis and decision-making. **Obj 6** Integrate imaging modalities into real-world biomedical applications, including in the development of diagnostic equipment. **Obj 7** Stay informed about the latest technological advancements in medical imaging and their clinical implications.

Necessary material :
None

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	***Introduction to Medical Imaging*** • *Overview of medical imaging techniques and their importance in healthcare.* • *General principles of imaging, from signal acquisition to image interpretation.* • *Overview of different imaging modalities: X-ray, CT, Ultrasound, MRI, PET, and SPECT.*	*6*	*Obj1*
3-5	***Computed Tomography (CT) Imaging*** • *Principles of CT: physics of X-rays and cross-sectional imaging.* • *The CT scanning process: image acquisition, reconstruction, and post-processing techniques.* • *Clinical applications of CT (e.g., neurological, abdominal, and chest imaging).* • *Advantages, limitations, and radiation dose considerations in CT.* • *Technological advancements and improvements in CT systems.*	*6*	*Obj1 ; Obj2*
6-7	***Ultrasound Imaging*** • *Principles of ultrasound: sound wave generation, propagation, and interaction with tissues.* • *Types of ultrasound imaging (2D, 3D, Doppler).* • *Applications of ultrasound in obstetrics, cardiology, musculoskeletal, and emergency diagnostics.* • *Advantages and limitations of ultrasound (non-invasive, real-time, and safety considerations).* • *Recent innovations in ultrasound technology.*	*6*	*Obj3*
8-10	***Magnetic Resonance Imaging (MRI)*** • *MRI principles: magnetic fields, radiofrequency pulses, and resonance phenomena.* • *MRI scanning process: image formation, different sequences, and contrast mechanisms.* • *Clinical applications of MRI in neurology, musculoskeletal, and cardiovascular imaging.* • *MRI safety, artifacts, and limitations.* • *Advanced MRI techniques (functional MRI, diffusion tensor imaging, and spectroscopy).*	*7.5*	*Obj4; Obj5*
11-14	***Integration of Imaging Techniques in Medical Practice*** • *Comparative analysis: when to use CT, Ultrasound, or MRI in clinical practice.*	*6*	*Obj 6; Obj7*

	• *Hybrid imaging technologies (PET/CT, PET/MRI) and their clinical relevance.* • *Role of medical imaging in treatment planning, surgical navigation, and patient monitoring.* • *Emerging trends in medical imaging and their impact on healthcare innovation.*		

3- Content elements (Practical work)

Week(s)	Activities/Content Elements	No. HR	Goals
…			…
…			…

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	X *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	X *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents* : ☐ *Yes* ☐ *No*
- *Authorized search engine* : ☐ *Yes* ☐ *No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Modern Diagnostic Imaging Technique Applications and Risk Factors in the Medical Field: A Review

The 5 Most Common Medical Imaging Techniques

Medical Imaging - an overview

The Differences in Medical Imaging Technologies

Saha, G. B. (2013). *Physics and Radiobiology of Nuclear Medicine* (4th ed.). Springer.

Hounsfield, G. N. (2003). *CT Scanning: The Basics and the Advances*. Springer.

Bushberg, J. T., Seibert, J. A., Leidholdt, E. M., & Boone, J. M. (2011). The Essential Physics of Medical Imaging (3rd Edition). Lippincott Williams & Wilkins.

Stoller, D. W. (2007). MRI in Practice (4th Edition). Wiley-Blackwell.

7- Working environment (Facilities necessary for learning)

- *Title, Version, URL*
- *…*

Course Specification

Telemedicine and Interoperability: Foundations and Technological Infrastructure

1. General

Coded	*ELEC – IB 5 103*	Level/Semester	*3/S5*	Coefficient	*3*	Credits	*3*
Course	*Electrical Engineering*					Volume. H. (CI)	*10.5*
Responsible	*Mr Sabri Barbaria*					Volume. H. (TP)	*21*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*41*
Module	*Telemedicine E-health*					Version	*09/2023*

Course description (Course objective):
In this telemedicine course, the focus is on the integration of interoperability standards into healthcare systems, with particular emphasis on healthcare enterprise integration initiatives. Participants will understand how interoperability standards can facilitate seamless communication between different healthcare stakeholders while exploring the foundations of telemedicine.

Prerequisites:	*Keywords :*
Basic knowledge of Computers and Information Technologies: *Understanding of basic computer science concepts.* *Familiarity with information technology, including networking and security.* *Basic programming skills*	*Web Technology*

Specific objectives of the course (OBJ):
OBJ 1: *Understand the Foundations of Telemedicine* ***OBJ 2:*** *Master the Technological Infrastructure* ***OBJ3:*** *Understanding Interoperability Standards and IHE* ***OBJ 4:*** *Apply Concepts in Practical Projects*

Necessary material :
Computers

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	*Introduction to Telemedicine*	*3*	*Definitions and objectives of telemedicine.* *Benefits and challenges associated with remote healthcare delivery.*
3-4	*Technological Infrastructure*	*3*	*Electronic medical records management (EMR) systems.* *Security standards and privacy in telemedicine applications.* *Demo: Configuring an EMR.*
5-7	*Interoperability Standards and IHE*	*4.5*	*Introduction to healthcare interoperability standards.* *Role of the IHE in promoting interoperability.* *Review of relevant IHE profiles.*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
8	*Configuration of the Development Environment*	*3*	*Obj 2*
9	*Implementation of a DMP (Medical File Sharing) example of openEMR*	*3*	*Obj 2 and 4*
10	*Database modeling and design*	*3*	*Obj 4*
11-12	*Bootstrap and javascript front end development*	*6*	*Obj 4 Obj 3*
13-14	*PHP back end development and back end database manipulation (CRUD)*	*6*	*Obj 4 Obj 3*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	x☐ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	x☐ *Yes* ☐ *No*	*60%*

EP - Practical test (TP- TP exam / MP- Mini project)	*☒ Yes ☐ No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Evaluation criteria

- *Authorized documents : ☐ Yes ☒ No*
- *Authorized search engine : ☐ Yes ☒ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *https://www.ihe.net/*
- *https://wiki.ihe.net/index.php/Main_Page*
- *https://www.hl7.org/*
- http://www.interopsante.org/
- Zhao, Y., & Zhang, X. (2019). Telemedicine and E-Health: Technologies and Applications. Wiley.
- Eysenbach, G. (2001). What is e-health? Journal of Medical Internet Research, 3(2), e20.

7- Working environment (Facilities necessary for learning)

- https://www.open-emr.org/
- https://getbootstrap.com/
- https://www.apachefriends.org/fr/download.html
- *https://code.visualstudio.com/*

Course Specification

Automated Systems and Biomedical Equipment Maintenance

1. General

Coded	*ELEC – IB 5 104*	Level/Semester	*3/S5*	Coefficient	*3*	Credits	*3*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*Mr Mouldi Ghdir*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, direct instructions,Project Based, Field Work					Self study H.	*38*
Module	*Biomedical Instrumentation*					Version	*09/2023*

Course description (Course objective):
This module aims to equip students with the knowledge and practical skills necessary to understand and apply automated systems in the maintenance of biomedical equipment. Students will learn how to optimize maintenance processes, ensure reliability, and extend the lifespan of biomedical devices through the use of automation and advanced diagnostic techniques.

Prerequisites:	*Keywords :*
Biology, LIS, digital electronics , analog electronics, computer network at laboratory level, automation, robotics, Grafcet, etc.	*Automation in medical analysis laboratories*

Specific objectives of the course (OBJ):
Obj 1 Understand the role and benefits of automated systems in the maintenance of biomedical equipment. **Obj 2** Comprehend the principles behind automated maintenance systems and the technologies involved. **Obj 3** Analyze the importance of sensors and monitoring systems in maintaining the accuracy and functionality of biomedical devices. **Obj 4** Apply the concept of predictive maintenance using automated systems and machine learning techniques. **Obj 5** Explore automated diagnostic and repair systems for biomedical equipment, including the role of robotics and smart diagnostics. **Obj 6** Gain an understanding of the regulatory and safety standards that govern the use of automated systems in healthcare settings. Obj **7** Develop practical knowledge of how to integrate automated systems into the maintenance workflow of biomedical equipment.

Necessary material :
None

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-3	***Introduction to Automated Systems in Biomedical Equipment*** • *Overview of automated systems: definition, types, and applications in healthcare.* • *Role of automation in the biomedical equipment industry: improving efficiency, precision, and reducing human error.* • *Benefits of automation in maintenance: predictive maintenance, reduced downtime, and cost optimization.*	*4.5*	*OBJ 1*
4-5	***Principles of Automated Maintenance Systems*** • *Key components of automated maintenance systems: sensors, actuators, controllers, and feedback loops.* • *Automation in diagnostics: self-monitoring and self-calibration systems.* • *Types of maintenance strategies: preventive, predictive, and corrective maintenance in the context of automated systems.* • *Tools and software for automated maintenance: remote diagnostics, computerized maintenance management systems (CMMS), and real-time monitoring systems.*	*4.5*	*OBJ 2*
6-7	***Sensors and Monitoring Systems for Biomedical Equipment*** • *Types of sensors used in biomedical equipment maintenance: temperature, pressure, humidity, and other physiological parameters.* • *The role of sensors in monitoring equipment performance and ensuring accuracy.* • *Integration of sensors with automated systems: data collection, analysis, and decision-making.* • *Calibration and maintenance of sensors to ensure reliability and performance.*	*6*	*OBJ 3*
8-9	***Predictive Maintenance and Automation in Biomedical Equipment*** • *Principles of predictive maintenance: data-driven decision-making, predictive algorithms, and early fault detection.* • *Case studies of predictive maintenance in biomedical equipment (e.g., MRI, ventilators, and infusion pumps).* • *Integration of machine learning and AI for predictive*	*6*	*OBJ 4*

	maintenance: data analysis and failure prediction models. • *Challenges and opportunities in implementing predictive maintenance systems in the biomedical field.*		
	Automated Systems for Troubleshooting and Repair • Automated diagnostic tools: error detection, troubleshooting, and repair processes. • The role of robotics in the repair and servicing of biomedical equipment: robotic arms, drones, and remote-controlled systems. • Smart diagnostics: using data from automated systems to guide technicians in the repair process. • Human-robot collaboration: optimizing the role of technicians and automated systems in maintenance operations.		*Obj 5*
	Regulations and Standards for Automated Systems in Biomedical Equipment Maintenance • Overview of regulatory frameworks: ISO 13485, FDA guidelines, and CE marking for biomedical equipment. • Safety standards for automated systems in healthcare environments: electrical safety, cybersecurity, and patient safety. • Ethical considerations in automation: privacy concerns, human oversight, and accountability in the maintenance of medical devices.		*Obj 6; Obj 7*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
10-11	*PH meter, Conductivity meter*	*3*	*OBJ 3- OBJ 4*
12-13	*Centrifuge, microcentrifuge, Ultracentrifuge, etc.*	*4.5*	*OBJ 5*
14	*Photonic and electron microscope*	*3*	*Obj 6- Obj 7*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	*X Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	X *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	X *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Evaluation criteria

- *Authorized documents : ☐ Yes X No*
- *Authorized search engine : ☐ Yes X No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Handbook of Biomedical Instrumentation: KHANDPUR

Biomedical Instrumentation: Technology and Applications

Principles of Biomedical Instrumentation

Books & eBooks - BTEC 221 - Medical Instrumentation

Carr, J. J., & Brown, J. M. (2011). Introduction to Biomedical Equipment Technology (4th ed.). Pearson.

Enderle, J. D., Bronzino, J. D., & Roche, J. (2012). Introduction to Biomedical Engineering (3rd ed.). Elsevier.

7- Working environment (Facilities necessary for learning)

- *None*

Course Specification

Programming and Integrating Robotic Systems with ROS2

1. General

Coded	*ELEC – IB 5 105*	Level/Semester	*3/S5*	Coefficient	*1.5*	Credits	*3*
Course	*Electrical engineering*					Volume. H. (CI)	*21*
Responsible	*Mr Sabri Barbaria*					Volume. H. (TP)	*10.5*
Teaching methods	Lecture, interactive, Field Work					Self study H.	*40.5*
Module	*Medical robotics*					Version	*09/2023*

Course description (Course objective):
By combining two cutting-edge technologies: ROS2, an open source robotics operating system, and the object-oriented Python programming language, this course provides a deep dive into the field of medical robotics. Students will have the opportunity to acquire the technical skills necessary to design, develop and deploy robotic applications in the medical context.

Prerequisites:	*Keywords :*
Knowledge of Python Programming *Basic Notions in Embedded Systems* *Development environment :* *Familiarity with integrated development environments (IDE)* *Ability to install and configure Python libraries.* *Linux Operating Systems*	*Python OOP, ROS, embedded electronics*

Specific objectives of the course (OBJ):
OBJ 1: Master the Fundamentals of ROS2 *OBJ 2: Apply Object Oriented Programming in Python* *OBJ 3: Integrate Robotic Components with ROS2* *OBJ 4: Design Intuitive Human-Machine Interfaces (HMI)* *OBJ 5: Simulate and Test Robotic Scenarios* *OBJ 6: Ensure Security and Compliance*

OBJ 7: Carry out Practical Projects *OBJ 8: Collaborate on Team Projects* *OBJ 9: Understanding Ethical and Social Challenges: Explore the ethical implications related to the use of robots in medicine. Analyze the social and legal challenges linked to medical robotics.*

Necessary material :
Computer with ubuntu system

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	*Introduction to Medical Robotics and Presentation of ROS2*	*3*	*Definition of medical robotics and applications.* *Overview of ROS2: basic concepts, architecture, tools.*
3-4	*Object Oriented Programming in Python and Integration of ROS2 with Python*	*4.5*	*Fundamentals of object-oriented (OO) programming in Python.* *Creation of classes and objects to represent robotic entities.* *Communication between nodes with ROS2.*
5-6	*Simulations and Tests with ROS2 and Node Development*	*4.5*	*Development of nodes in Python for the control of medical robots.* *Use of ROS2 simulators to test algorithms.* *Implementation of test scenarios to assess reliability.*
7-8	*Human-Machine Interfaces (HMI) and User Interaction*	*4.5*	*Design of intuitive HMIs for controlling medical robots.* *HMI integration with ROS2 functionalities*
9-10	*Security, Compliance and Practical Projects*	*4.5*	*Safety considerations in medical robotic applications.* *Compliance with medical standards and regulations.* *Preparation for practical projects.*

3- Content elements (Practical work)

Week(s)	Activities/Content Elements	No. HR	Goals
11	*Configuration of the Development Environment*	*1.5*	*Installation and configuration of ROS2 and the Python environment.*
12	*Object-Oriented Python Programming, Development of ROS2 Nodes in Python.*	*3*	*Creation of classes and objects to model robots. Creation of communication nodes for robotic components.*
13	*Simulations and Tests with ROS2*	*3*	*Use of simulators to test algorithms and scenarios.*
14	*Design of Human-Machine Interfaces (HMI)*	*3*	*Creation of graphical HMIs for the control of medical robots.*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	x *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	x *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	X *Yes* ☐ *No*	*20%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- ***CI+TP material : Average = 20% DS + 20% EP + 60% EE***

5- Evaluation criteria

- *Authorized documents : ☐ Yes X No*
- *Authorized search engine : ☐ Yes X No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *Koubaa, A. (2021). Robot Operating System (ROS) The Complete Reference (Volume 5);*
- *https://www.ros.org/blog/getting-started/#*
- *https://www.python.org/*
- *https://app.theconstructsim.com/*
- *Siciliano, B., & Khatib, O. (2016). Springer Handbook of Robotics (2nd ed.). Springer.*
- *Zinn, M., & Goldberg, K. (2018). Medical Robotics: Minimally Invasive Surgery (2nd ed.). Wiley.*

7- Working environment (Facilities necessary for learning)

- *https://www.ros.org/blog/getting-started/#*
- *https://www.python.org/downloads/*
- *https://ubuntu.com/download*

Course Specification

Nuclear Instrumentation and Radiation Applications

1. General

Coded	*ELEC - IB 5 106*	Level/Semester	*3/S5*	Coefficient	*1.5*	Credits	*3*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Option	*Mr Mounir Zrafi*					Volume. H. (TP)	*0*
Teaching methods	Lecture, interactive, Field Work					Self study H.	*50*
Module	*Electronics & Nuclear Instrumentation*					Version	*09/2023*

Course description (Course objective):
The objective of this module is to provide students with a thorough understanding of the principles, technologies, and applications of nuclear instrumentation and radiation in the biomedical field. The course covers the detection, measurement, and safety aspects of nuclear instrumentation and radiation, along with their practical applications in medicine and healthcare.

Prerequisites:	*Keywords :*
biophysics, analog and digital electronics, instrumentation, electrical diagrams or equivalent units	**Nuclear electronics, nuclear instrumentation, nuclear detection, nuclear interaction…**

Specific objectives of the course (OBJ):
Obj 1 : Understand the principles of nuclear physics and radiation interaction with matter in biomedical contexts. Obj 2 : Comprehend the various types of nuclear instrumentation used in radiation detection and measurement. Obj 3 : Apply radiation dosimetry techniques for assessing radiation doses in medical settings. Obj 4 : Explore the medical applications of nuclear instrumentation, particularly in diagnostic imaging *and therapeutic radiation.* Obj 5 : *Learn the importance of radiation safety and protection in nuclear instrumentation.* Obj 6 : *Gain insight into the advanced techniques in nuclear instrumentation, including emerging technologies and integration with digital systems.* Obj 7 : *Evaluate the ethical, legal, and social implications of nuclear radiation use in the biomedical field.*

Necessary material :
…

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	***Introduction to Nuclear Instrumentation*** • *Fundamentals of nuclear physics: properties of radiation, types of radiation (alpha, beta, gamma), and their interaction with matter.* • *Basic principles of radiation detection: ionization, scintillation, and semiconductor detectors.* • *Types of nuclear instruments used in biomedical applications: Geiger-Müller counters, scintillation counters, ionization chambers, and semiconductor detectors.* • *Overview of radiation sources used in medical applications: isotopes, accelerators, and radiation generators.*	*3*	*OBJ1*
3-4	***Radiation Measurement and Detection Techniques*** • *Radiation dosimetry: measurement of radiation doses and their biological effects.* • *Calibration of radiation detectors: standards, procedures, and quality control.* • *The role of detectors in radiation therapy: measuring dose distribution and ensuring accuracy.* • *Techniques for imaging radiation: X-ray, CT, PET, SPECT, and their interaction with tissues.*	*3*	*OBJ2*
5-6	***Applications of Nuclear Instruments in Medicine*** • *Diagnostic applications: nuclear medicine, imaging systems, and the role of isotopes (e.g., Technetium-99m in SPECT).* • *Therapeutic applications: radiotherapy techniques (e.g., brachytherapy, external beam radiotherapy) and the role of radiation in cancer treatment.* • *The use of radiation in sterilization and disinfection of medical equipment.* • *The role of nuclear instrumentation in radiology and radiation oncology departments.*	*4.5*	*OBJ3, OBJ 4*
7-8	***Radiation Safety and Protection*** • *Safety standards and regulations in nuclear instrumentation: IAEA, NRC, and other regulatory bodies.* • *Radiation protection principles: ALARA (As Low As Reasonably Achievable), shielding, distance, and time.*	*3*	*OBJ5*

	• *Personal protective equipment (PPE) and monitoring for radiation exposure: dosimeters, radiation badges, and safety protocols.* • *Environmental monitoring of radiation: controlling contamination and waste management.*		
9-10	***Advanced Techniques in Nuclear Instrumentation*** • *Recent developments in nuclear instrumentation: digital detectors, high-resolution imaging, and real-time radiation monitoring.* • *Integration of nuclear instruments with computer systems for data analysis and image processing.* • *Emerging technologies: molecular imaging, gamma cameras, and portable radiation detectors.* • *The role of AI and machine learning in enhancing the accuracy and efficiency of nuclear instrumentation and radiation applications.*	*4.5*	*OBJ6*
11-12	***Ethical, Legal, and Social Implications of Nuclear Radiation in Medicine*** • *Ethical considerations in the use of nuclear radiation in medicine: patient consent, risks, and benefits.* • *Legal and regulatory aspects of nuclear instrumentation in healthcare: licensing, certification, and compliance with safety standards.* • *Public perception and societal concerns regarding the use of radiation in medical practice.* • *Environmental impact and sustainability of radiation applications in medicine.*	*3*	*OBJ7*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
…	…	…	…
…	…	…	…

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	X *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	X *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***<u>100% CI material : Average = 40% DS + 60% EE</u>***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes ☐ No*
- *Authorized search engine : ☐ Yes ☐ No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Electronics for Nuclear Instrumentation : Chiang, Hai Hung

Ultra Electronics Nuclear Sensors & Process Instrumentation

Nuclear electronic instrumentation

Rao, P. S. (2017). Electronic Instrumentation and Measurement Techniques. Pearson.

Knoll, G. F. (2010). Radiation Detection and Measurement (4th ed.). Wiley.

Harrison, R. W., & Thompson, S. K. (2015). Nuclear Medicine and Radiation Therapy: Principles and Practice. Springer.

Knoll, G. F. (2010). Radiation Detection and Measurement (4th Edition). Wiley.

7- Working environment (Facilities necessary for learning)

- *Title, Version, URL*
- *…*

Course Specification

Biomedical Management: Quality, Maintenance and Procurement

1. General

Coded	EL-IB 5 107	Level / Semester	*3/S5*	Coefficient	*1.5*	Credits	*2*
Course	*Electrical Engineering*					Volume. H. (CI)	*21*
Responsible	*Mr. Mouldi Ghdir*					Volume.. H. (TP)	*0*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*29*
Module	*Qualitology and CMAO*					Version	*09/2023*

Course description (Course objective):
The goal of this module is to provide students with an understanding of the key principles of biomedical equipment management, with a focus on quality assurance, maintenance strategies, and procurement processes. The module will explore how to manage biomedical equipment efficiently to ensure reliability, compliance with standards, and cost-effectiveness in healthcare settings.

Prerequisites :	*Keywords :*
. Accreditation , IT, management, finance, law, etc.	*Qualitology , CMAO, Organization chart*

Specific objectives of the course (OBJ $_i$):
Obj 1 : Understand the management processes and organizational structure involved in biomedical equipment management. Obj 2 : *Comprehend the principles and practices of quality management in the context of biomedical equipment.* *Obj 3 : Develop strategies for the maintenance and optimization of biomedical equipment, including preventive, predictive, and corrective maintenance.* *Obj 4 : Gain insight into procurement practices and vendor management for acquiring biomedical equipment.* *Obj 5 : Understand the regulatory compliance requirements and the importance of accreditation in the management of biomedical equipment.* *Obj 6 : Learn about sustainability and environmental factors in biomedical equipment management.*

Necessary material :
None

2- Content elements (Course)

Week (s)	Chapters / Content Items	No. HR	Goals
1-2	***Introduction to Biomedical Equipment Management*** • ***Overview of biomedical equipment management: roles, responsibilities, and organizational structure.*** • ***Key challenges in managing biomedical equipment: cost control, regulatory compliance, and technological obsolescence.*** • ***The importance of lifecycle management in ensuring equipment performance and minimizing downtime.*** • ***Integration of management processes in healthcare facilities (hospitals, clinics, research labs).***	*3*	*OBJ 1*
3-4	***Quality Management in Biomedical Equipment*** • *Principles of quality management in the biomedical field: total quality management (TQM), Six Sigma, and Lean principles.* • *Standards and regulations for quality in biomedical equipment: ISO 13485, FDA, CE Mark, and medical device regulations.* • *Methods of quality assurance and control: testing, validation, calibration, and maintenance protocols.* • *Best practices for ensuring the quality and safety of biomedical devices throughout their lifecycle.*	*3*	*OBJ 2*
5-6	***Maintenance Management of Biomedical Equipment*** • *Maintenance strategies for biomedical equipment: preventive, predictive, and corrective maintenance.* • *Role of maintenance teams: technicians, engineers, and biomedical equipment specialists.* • *Tools and software for maintenance management: Computerized Maintenance Management Systems (CMMS), asset management tools, and data analytics.* • *Maintenance scheduling, documentation, and record-keeping to ensure compliance and operational efficiency.* • *Spare parts management and vendor relations for effective maintenance operations.* *Qualification of equipment*	*3*	*OBJ 3*
7-8	***Procurement of Biomedical Equipment*** • *Principles of procurement management: sourcing, purchasing, and contract negotiations.* • *Criteria for selecting biomedical equipment: technical specifications, cost, reliability, and compliance with medical standards.* • *Procurement processes: vendor selection, tendering, purchasing contracts, and supplier management.* • *Risk management in procurement: evaluating the reliability and reputation of suppliers, ensuring the availability of spare parts, and warranty conditions.* • *Budgeting and financial planning for the procurement of biomedical equipment.*	*3*	*OBJ 4*

9-11	***Regulatory Compliance and Accreditation in Biomedical Equipment Management*** • Regulatory requirements for biomedical equipment: understanding international standards (e.g., ISO, FDA, IEC) and national regulations. • Compliance with safety and performance standards: ensuring that biomedical equipment meets the required safety and efficacy standards. • Accreditation bodies and their role in healthcare facilities: JCI, NABH, and others. • The role of management in maintaining compliance with these regulations and ensuring safety in healthcare environments.	*4.5*	*OBJ 5*
12-14	***Sustainability and Environmental Considerations in Biomedical Equipment Management*** • *Environmental impact of biomedical equipment: waste management, energy consumption, and e-waste disposal.* • *Sustainable procurement practices: sourcing environmentally friendly products, extending equipment lifespan, and reducing carbon footprint.* • *The role of green technologies in the development and maintenance of biomedical equipment.* • *Strategies for minimizing the environmental impact of biomedical operations.*	*4.5*	*OBJ 6*

3- Content elements (Practical work)

Week (s)	Activities / Content elements	No. HR	Goals
			…
			…

4- Methods evaluation & distribution of marks

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation , Report, etc.)	☐ *Yes* ☐ *No*	
DS - Supervised Duty	x☐ *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	x☐ *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Criteria devaluation

- *Authorized documents : ☐ Yes X No*
- *Authorized search engine : ☐ Yes X No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

Qualitology - Pharmacognosy - Extraction and Separation , course

CMAO: Definition, Key Features and Benefits

Juran, J. M., & Godfrey, A. B. (1998). Juran's Quality Handbook (5th ed.). McGraw-Hill.

Juran, J. M., & Gryna, F. M. (1993). Quality Control Handbook (5th ed.). McGraw-Hill.

7- Working environment (Facilities necessary for learning)

- *None*

Course Specification

Industry 4.0

1.General

Coded	*ELEC-SE 5 109*	Level/Semester	*3/S5*	Coefficient	1.5	Credits	2
Course	*Industrial Engineering*					Volume. H. (CI)	*21*
Responsible	*Mounir FRIJA*					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*29*
Module	Industry 4.0					Version	*09/2023*

Course description (Course objective):
In this course you will see a specialization overview, learn what Industry 4.0 is all about, learn about the enabling factors that made it, and become aware of what key skills to learn to be employed in the industry 4.0 market segment.

Prerequisites:	*Keywords:*
- Information system - The basics of production management - basic knowledge in electronics - basic knowledge in IT	

Specific objectives of the course (OBJ):
OBJ 4 : Describe the key concepts of Industry 4.0 ***OBJ 5 :*** List the core elements of i4.0 ***OBJ 6 :*** Being Able to Apply i4.0 concepts to a manufacturing environment

Necessary material:
- ***None***

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals

1-4	***Chapter 1:*** Overview industry 4.0	*3*	- The Evolution of Industry from 1.0 to 4.0 - Use cases: smart factory. - Benefits of Adopting an Industry 4.0 Model - Vertical and horizontal integration
5 -8	***Chapter 2:*** CPS & IT tools	6	- Overview CPS - IIOT & CLOUD - MY - ERP - CRM
9-11	***Chapter 3:*** Management 4.0	*6*	- Change Management for Industry 4.0
12-14	***Chapter 4:*** Competence for Industry 4.0	*6*	- Lean 4.0 - Worker 4.0

3- Content elements (Practical work)

Week(s)	Activities/Content Elements	No. HR	Goals

...	...	...	...
...	...	...	...
12	*Practical exam, mini-project defense, ...*	*3h*	*Summative evaluation*

4- Evaluation methods & Marks Distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☒*No*	*20%*
DS - Supervised Duty	☐ *Yes* ☒*No*	*20%*
EE - Written test (Final exam)	☐ *Yes* ☒*No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☒*Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes ☒No*
- *Authorized search engine : ☐ Yes ☐ No*
- *Criterion 1: Understanding of the content (4 points)*
- *Criterion 2: Application of knowledge (10 points)*
- *Criterion 3: Critical analysis (4 points)*
- *Criterion 4: Clarity and organization (2 points)*
- *)*

6- Web references (useful links):

1. odoo.com
2. rettel, M., Friederichsen, N., Keller, M., & Rosenberg, M. (2014). How virtualization, decentralization and network building change the manufacturing landscape: An Industry 4.0 perspective. International Journal of Mechanical, Industrial Science and Engineering, 8(1), 37-44.
3. Lasi, H., Fettke, P., Kemper, H. G., & Feld, T. (2014). Industry 4.0. Business & Information Systems Engineering, 6(4), 239-242.

7- Working environment (Facilities necessary for learning)

- *Industry 4.0 laboratory , computer laboratory*

Course Specification

Atomic and Nuclear Physics for Medical Applications

1. General

Coded	ELEC – IB 5 109	Level/Semester	3/S5	Coefficient	1.5	Credits	2
Course	Electrical engineering					Volume. H. (CI)	21
Option	Mrs Ameni Lahouar					Volume. H. (TP)	0
Teaching methods	Lecture, interactive, direct instructions					Self study H.	26
Module	Biophysics and atomic and nuclear physics					Version	09/2023

Course description (Course objective):
The aim of this module is to provide students with a comprehensive understanding of atomic and nuclear physics principles and their applications in the medical field. This includes the study of radiation physics, medical imaging, radiation therapy, and nuclear medicine. The course will also cover the interactions of radiation with matter, safety measures, and advancements in the medical use of nuclear technologies.

Prerequisites:	*Keywords :*
Mathematics for engineers	*Radiation, detection, radioactivity*

Specific objectives of the course (OBJ):
Obj 1 : Understand the basic principles of atomic and nuclear physics, including radiation types, decay processes, and interactions with matter. ***Obj 2 :*** Learn the role of nuclear reactions and radioactive decay in medical applications such as diagnostics and treatment. ***Obj 3 :*** Explore how radiation is used in medical imaging techniques, including X-ray, CT, PET, and SPECT. ***Obj 4 :*** Understand the principles of radiation therapy and its clinical applications in treating cancer. ***Obj 5 :*** Gain knowledge of radiation protection standards, safety measures, and monitoring techniques to ensure the safe use of radiation in healthcare settings.

Necessary material :
Nothing

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	***Introduction to Atomic and Nuclear Physics*** • *Fundamentals of atomic structure: protons, neutrons, electrons, and atomic interactions.* • *Overview of nuclear structure:*	*3*	*Obj 1*

	isotopes, nuclear reactions, and radioactivity. • *Types of nuclear radiation: alpha, beta, gamma, and neutron radiation.* • *The interaction of radiation with matter: absorption, scattering, and ionization processes.* ⍰		
3-4	***Nuclear Reactions and Radioactive Decay*** • *Types of nuclear reactions: fission, fusion, and induced nuclear reactions.* • *Radioactive decay: half-life, decay modes (alpha, beta, gamma), and decay chains.* • *Measurement of radiation: activity, dose, and units of radiation measurement (Becquerels, Sieverts, Gray).* • *Applications of radioactive decay in medical diagnostics and treatment.*	*3*	*Obj 2*
5-6	***Radiation Physics in Medical Applications*** • *Principles of radiation interaction with biological tissues: dosimetry, energy deposition, and biological effects.* • *The role of ionizing radiation in medical imaging techniques: X-ray, CT, PET, and SPECT.* • *Principles of nuclear medicine: use of radiopharmaceuticals for diagnostic and therapeutic purposes.* • *Radiation therapy: principles of radiation dose delivery in cancer treatment.*	*3*	*Obj 3*
7-9	***Medical Imaging with Nuclear and Ionizing Radiation*** • *X-ray and CT imaging: principles of operation, detectors, and image formation.* • *Positron Emission Tomography (PET): imaging principles, tracer*	*4.5*	*Obj 3*

	selection, and applications in oncology and cardiology. • *Single Photon Emission Computed Tomography (SPECT): principles, instrumentation, and clinical applications.* • *The role of radiation in molecular imaging and advanced diagnostic techniques.*		
10-11	***Radiation Therapy and Treatment Applications*** • Overview of radiation therapy: external beam radiotherapy, brachytherapy, and proton therapy. • Dose planning in radiation therapy: linear accelerators, treatment planning systems, and patient-specific dosimetry. • The role of radiation in treating various cancers: tumor targeting, dose distribution, and side-effect management. • Emerging trends in radiation therapy: proton therapy, targeted radiation, and radiosensitization.	*3*	*Obj 4*
12-14	***Radiation Protection and Safety in Medical Applications*** • Radiation protection principles: time, distance, and shielding. • Regulatory standards and safety guidelines: ICRP, NCRP, and other international bodies. • Personal protective equipment (PPE) and safety measures for medical staff and patients. • Monitoring radiation exposure: dosimetry, contamination control, and environmental monitoring.	*4.5*	*Obj 5*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
…	…	…	…
…	…	…	…

14	*Practical exam, mini-project defense, …*	*3h*	*Summative evaluation*

4- Evaluation methods & Marks distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* *X No*	
DS - Supervised Duty	X *Yes* ☐ *No*	*40%*
EE - Written test (Final exam)	X *Yes* ☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* *X No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : ☐ Yes X No*
- *Authorized search engine : ☐ Yes X No*
  - *Criterion 1: Understanding of the content (4 points)*
  - *Criterion 2: Application of knowledge (10 points)*
  - *Criterion 3: Critical analysis (4 points)*
  - *Criterion 4: Clarity and organization (2 points)*

6- Web references (useful links):

- *Biophysique, physique du vivant*
- *Wilson, J. & Hawkes, J. F. B. (2014). Optics and Lasers: Including Fibers and Optical Communication (4th ed.). Prentice Hall.*
- *Krane, K. S. (1987). Introductory Nuclear Physics. Wiley.*
- ***Knoll, G. F. (2010).** Radiation Detection and Measurement (4th Edition). Wiley.*
- *This book provides an extensive introduction to radiation detection techniques, nuclear physics, and their application in medical instrumentation, focusing on dosimetry and safety standards.*
- ***Harrison, R. W., & Thompson, S. K. (2015).** Nuclear Medicine and Radiation Therapy: Principles and Practice. Springer.*

7- Working environment (Facilities necessary for learning)

- *Title, Version, URL*
- *…*

language module sheets

Process of test of placement LANGUAGES (English & French)

- ***New students :***
  - **Registration & Admission**

All the new students has their admission has the PI register in line via a platform dedicated to the passage of tests level of languages “MyEPIADMISSION”

They provide of the information personal such that their name, their address E-mail And their number of CIN ..

- **Planning & Passage of Test of level :**

A times registered, THE students receive a confirmation registration And are scheduled For pass the tests in English And in French

THE tests are planned In THE labs of LANGUAGES .They pass THE test of language on PC (MCQ) Who evaluate their SKILLS linguistics

- **Fix of the Testing of level :**

THE tests are corrected automatically by the software And the results are generated instantly once that THE test East finished.

THE results are analyzes For determine the level of language of each student .

- **Attribution of the levels of language :**

THE levels are based on of the standards international such that THE frame European common of reference For the LANGUAGES (CEFR)

- **Ranking In the groups of LANGUAGES & Notification of the results :**

In function of their level of language, THE students are assigned has of the groups of language appropriate.

These groups can be constituted in function of level :

1- Beginner =A
2- Intermediate =B
3- Advanced = C

- **Notification of the results ;**

THE students receive their results via the app And Who understand their level of language And their assignment has A band specific

THE students are Next affected In their groups of language according to THE jobs of LANGUAGES displayed on the app

Follow up And assessment :

THE progress of the students are followed All At long of their course learning

Of the assessment periodicals are carried out such that (projects PPT , tests oral, exercises ..) For adjust their progression in function of their needs .

These process guarantee a assessment precise of level of language of the students And their assignment has of the course appropriate For to favor their learning linguistic

Former students:

Transition of former students from one level to another:

For language levels (former 23.24 => 24.25)

Initial level = A & Average 23.24 <13 → Level A (24.25)
Initial level = A & Average 23.24 >13 → Level B (24.25)
** Initial level = B & Average 23.24 <13 → Level B (24.25)
** Initial level = B & Average 23.24 >13 → Level C (24.25)
**Level C =>15 → Level C (24/25)

Course Specification

French (Level A*)*

1. General

Coded	*EN-ABC*	Level/Semester	*1-2*	Coefficient	*1.5*	Credits	*2*
Course	*engineering*					Volume. H. (CI)	*21*
Responsi ble	*Sami MZOUGHI*					Volume. H. (TP)	*0*
Teaching methods	Lecture, interactive, direct instructions,Project Based					Self study H.	*20*
Module	*Languages & Communication*					Version	*09/2023*

Course description (Course objective):
A -level French courses aim to develop the student's ability to understand the essential points of a message written in clear, standard language. The course materials are taken from Inspire 3, a DELF manual. They also aim to prepare the student to produce simple and coherent speeches on familiar subjects. Oral is preferred in all sessions.

Prerequisites:	*Keywords:*
Understand simple, decontextualized sentences. Communicate in a simple way.	*Understand, listen, communicate, react*

Specific objectives of the course (OBJ):
OBJ 1 : *Understand the materials and respond to instructions.* ***OBJ 2 :*** *Participate orally in debates around the proposed subject.* ***OBJ 3 :*** *Form a personal opinion.*

Necessary material:
Sound recording / JBL

2- Content elements (Course)

Week(s)	Chapters/Content Items	#HR	Goals
1-2	*1st unit: Is it possible to be different and live together?*	*3 hours*	*- talking about oneself* *- understand others.* *- explain cultural differences.*
3-4	*2nd Unit: Are we all journalists?*	*3 hours*	*- talk about information professions.*

			- transmit information. *- question the information.*
5-6	*3rd Unit: Why do we travel?*	*3 hours*	*Tell about an experience.* *- talk about tourism* *- think about the trip.*
7-8	*4th Unit: Describing a profession*	*3 hours*	*- collect information about a profession.* *- talk about responsibilities.* *- the skills required for each profession.*
9-11	5th Unit: Organize a remote activity	4.5 hours	- discuss teleworking. - understand the advantages and challenges of managing remote activities.
12-14	6th Unit: Can we fight inequalities?	4.5 hours	- tell about a commitment. - to give his opinion. - talk about inequalities.

3- Evaluation methods & Marks Distribution

Type of assessment	Yes No		Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes*	☒*No*	-
DS - Supervised Duty	☒*Yes*	☐*No*	*40%*
EE - Written test (Final exam)	☒*Yes*	☐*No*	*60%*
EP - Practical test (TP- TP/MP exam- Mini project)	☐ *Yes*	☒*No*	-

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

4- Evaluation criteria (of written production)

- *Authorized documents* : ☐*Yes*☐ *No*
- *Search engine allowed* : ☐*Yes*☐ *No*
- *Criterion 1: Understanding of the instructions: (8 points)*
- *Criterion 2: Relevance of ideas: (4 points)*
- *Criterion 3: Linguistic correction: (6 points)*
- *Criterion 4: Originality: (2 points)*

5- Web References (useful links):

- *Author, Title, Year*
- Learn.TV5Monde

6-Working environment (Facilities necessary for learning)

- *None*
- *...*

Course Specification

French (Level B)

1. General

Coded	*EN-ABC*	Level/Semester	*3-4*	Coefficient	*1.5*	Credits	*2*
Course	*engineering*					Volume. H. (CI)	*21*
Responsible	*Sami MZOUGHI*					Volume. H. (TP)	*0*
Teaching methods	Lecture, interactive, direct instructions,Project Based					Self study H.	*20*
Module	*Languages & Communication*					Version	*09/2023*

Course description (Course objective):
Level B courses set the objectives of understanding audio documents, understanding press articles and other authentic texts. Written production sessions are also on the program to introduce the student to the code of writing by inviting them to write various texts. The course materials are taken from Inspire 4, a DELF manual.

Prerequisites:	*Keywords:*
The student can understand isolated sentences and frequently used expressions. He can also communicate orally and describe his training using simple means, and address some subjects that concern him closely.	*Understand, communicate, describe, discuss subjects.*

Specific objectives of the course (OBJ):
***OBJ 4 :** Understand the educational documents specific to each lesson.* ***OBJ 5 :** Take a position on the subjects or problems raised by the materials.* ***OBJ 6 :** Imagine other ways of acting.*

Necessary material:
Paper version documents / Sound recordings / JBL

2- Content elements (Course)

Week(s)	Chapters/Content Items	#HR	Goals
1-2	*Does work have the same meaning today?*	*3 hours*	*explain professional trends analyze the workplace.*

			reveal professional taboos.
3-4	*How is technology transforming our lives?*	*3 hours*	*- improve a living space.* *- take a position on virtual meetings.* *- imagine new worlds.*
5-6	*Can we still save the planet?*	*3 hours*	*- make an inventory of pollution.* *-alert the public to a risk.* *-propose solutions*
7-8	*Is politics everyone's business?*	*3 hours*	*- define rights and duties.* *- defend a commitment.* *- question the right to vote.*
9-11	*Are we prisoners of our appearance?*	*4.5 hours*	- tell of discrimination. -imagine the human of the future. - talk about your appearance.
12-14	Is happiness utopian?	4.5 hours	- give a definition of happiness. - analyze preconceived ideas. - envision happiness.

3- Evaluation methods & Marks Distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☒*No*	-

DS - Supervised Duty	☒*Yes*	☐*No*	*40%*
EE - Written test (Final exam)	☒*Yes*	☐*No*	*60%*
EP - Practical test (TP- TP/MP exam- Mini project)	☐ *Yes*	☒*No*	-

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

4- Evaluation criteria (of written production)

- *Authorized documents : ☐Yes☐ No*
- *Search engine allowed : ☐Yes☐ No*
- *Criterion 1: Understanding of the subject and organization of the text: (8 points)*
- *Criterion 2: Care given to expression (6 points)*
- *Criterion 3: Knowledge of the subject: (4 points)*
- *Criterion 4: Originality of ideas: (2 points)*

5- Web References (useful links):

- *Author, Title, Year*
- *Learn.TV5Monde*

6-Working environment (Facilities necessary for learning)

- *None*
- *...*

Course Specification

French (Level C)

1. General

Coded	*EN-ABC*	Level/Semester	*5-6*	Coefficient	*1.5*	Credits	*2*
Course	*engineering*					Volume. H. (CI)	*21*
Responsible	*Sami MZOUGHI*					Volume. H. (TP)	*0*
Teaching methods	Lecture, interactive, direct instructions,Project Based					Self study H.	*20*
Module	*Languages & Communication*					Version	*09/2023*

Course description (Course objective):
The French Communication Techniques course, at level C, aims to develop three skills in the student: Comprehension of writing (CE), Oral production (PO) and Written production (PE), with a view to preparing them for the DELF exam. The course material is generally a paper version document which offers various educational activities, relating to the materials. The role of the teacher is to provide the student with a certain autonomy in the search for answers. The supports are those of DELF B 2, 2nd Edition - 100% SUCCESS.

Prerequisites:	*Keywords:*
In principle, the student should have the following abilities: understand the essential points of a discussion, a text, a press article when the language used is clear and standard and when it concerns familiar subjects having relates to the daily life of the student.	*Understand, listen well, interact*

Specific objectives of the course (OBJ):
OBJ 7 : *Make reading hypotheses and generally understand the content of a document.* ***OBJ 8 :*** Enter message scopes. ***OBJ 9 :*** React to messages. ***OBJ 10 :*** For PE, acquire a methodology allowing successful written productions.

Necessary material:
Paper version documents - Sound recordings - JBL

2- Content elements (Course)

Week(s)	Chapters/Content Items	#HR	Goals

1-2	*CE: How to read a text? / A set of short texts.* *PE: Analysis of the instructions / Different statements of written production*	*3 hours*	*Help the student understand various texts.* *Understand what is required by the instructions.*
3-4	*CE: Analysis of positions/testimonies* *PE: Learn to present a situation, facts / Various texts.*	*3 hours*	*Identification of tone, point of view.* *Learn to identify a situation, facts*
5-6	*CE: Search for relevant information / Various texts.* *PE: Expression of personal opinion / PE topics.*	*3 hours*	*Identification of the content of a text.* *Help to formulate ideas, to qualify your comments, to formulate proposals*
7-8	*informative text: its content, its characteristics.* *PE: Text production / Writing workshop.*	*3 hours*	*Enter the content of a text and report it in writing.* *PE: Master the structure of the text to be produced.*
9-11	*CE: The argumentative text / Various texts* *PE: Writing a formal letter. / Written production instructions.*	*4.5 hours*	*CE: Learn to recognize an argumentative text and gNonep its specific features.* *PE: Learn the formal characteristics of the letter.*
12-14	*CE: Analysis of points of view / Written testimonies*	*4.5 hours*	*Recognize the different positions and their nuances.*

3- Evaluation methods & Marks Distribution

Type of assessment	Yes No		Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes*	☒*No*	-
DS - Supervised Duty	☒*Yes*	☐*No*	*40%*
EE - Written test (Final exam)	☒*Yes*	☐*No*	*60%*
EP - Practical test (TP- TP/MP exam- Mini project)	☐ *Yes*	☒*No*	-

- *Material 100% TP : Average = 20% CC + 80% EP*
- *100% CI material : Average = 40% DS + 60% EE*
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

4- Evaluation criteria (of written production)

- *Authorized documents : ☐Yes☐ No*
- *Search engine allowed : ☐Yes☐ No*
- *Criterion 1: Understanding of the subject structuring of the text: (8 points)*
- *Criterion 2: Relevance of the argument: (6 points)*
- *Criterion 3: Linguistic correction: (4 points)*
- *Criterion 4: Originality of ideas: (2 points)*

5- Web References (useful links):

- *Author, Title, Year*
- Learn.TV5Monde

6- Working environment (Facilities necessary for learning)

- *None*
- *...*

Course Specification

English (A level)

1. General

Coded	ENG-ABC	Level/Semester	1-2	Coefficient	1.5	Credits	2
Course	engineering					Volume. H. (CI)	21
Responsible	Sawcen LAAMIRI					Volume. H. (TP)	0
Teaching methods	Lecture, interactive, direct instructions,Project Based					Self study H.	24
Module	Languages & Communication					Version	09/2023

Course description (Course objective):
Whether you already have some basic English or are completely new to it, our English program is divided into three levels (A, B and C). At the start of the academic year, your teacher will define your objectives with you and test your level during an initial assessment in order to help you integrate one of the three levels. - *You will be able to acquire or strengthen your basics in business English as well as your self-confidence.* - *You will review and learn the grammatical, oral and written basics.* - *You will learn to communicate orally and in writing and you will enrich your vocabulary.* - *You will be able to respond orally and follow a conversation.*

Prerequisites:	*Keywords:*
Level A: *No specific knowledge necessary*	*Business English*

Specific course objectives (OBJ):
OBJ 11 : *Oral expression: acquisition of vocabulary relating to working English (Business English)* ***OBJ 12 :*** *Written expression: writing letters, messages, formats, references, abbreviations, etc.* ***OBJ 13 :*** *The fundamentals: tense, auxiliaries, adjectives, comparatives, pronouns*

Necessary material:
The printed course purchased from the printing, data show and baffles service

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	*The working day*	*3h*	*Vocab: Company departments (ex: HR, PR, finance) and job titles (ex: production manager)* *Gr: present simple and present continuous*
3-4	*Corporate culture*	*3h*	*Vocab: corporate culture vocabulary and asking for information* *Gr: collocations*
5-6	*Developing contacts*	*3h*	*Networking vocabulary, present perfect and past simple tenses*
7-8	*Cultural issues*	*3h*	*Cultural awareness, marketing in China and business in Finland vocabulary*
9-10	*Teamwork*	*3h*	*Describing a team, slogans, team-building and verbs with their corresponding nouns and adjectives*
11-12	*Job applications*	*3h*	*How to write a CV, a letter of application and wait for an interview*
13-14	*Revision*	*3h*	*Tenses and vocabulary of all chapters*

3- Evaluation methods & Marks Distribution

Type of assessment	Yes No		Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes*	☒*No*	
DS - Supervised Duty	☒*Yes*	☐*No*	*40%*
EE - Written test (Final exam)	☒*Yes*	☐*No*	*60%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

4- Evaluation criteria (of written production)

- *Authorized documents : ☐Yes☐ No*
- *Search engine allowed : ☐Yes☐ No*
- *Criterion 1: Understanding of the subject structuring of the text: (8 points)*
- *Criterion 2: Relevance of the argument: (6 points)*
- *Criterion 3: Linguistic correction: (4 points)*
- *Criterion 4: Originality of ideas: (2 points)*

5- Web References (useful links):

- *TOIC; TOFEL*

6-Working environment (Facilities necessary for learning)

- *None*
- *…*

Course Specification

English (level B)

1. General

Coded	*ENG-ABC*	Level/Semester	*3-4*	Coefficient	*1.5*	Credits	*2*
Course	*Engineering*					Volume. H. (CI)	*21h*
Responsible	*Sawcen LAAMIRI*					Volume. H. (TP)	*0*
Teaching methods	Lecture, interactive, direct instructions,Project Based					Self study H.	*24*
Module	*Languages & Communication*					Version	*09/2023*

Course description (Course objective):
Whether you already have some basic English or are completely new to it, our English program is divided into three levels (A, B and C). At the start of the academic year, your teacher will define your objectives with you and test your level during an initial assessment in order to help you integrate one of the three levels. *You will be able* ***to acquire or strengthen your basics in business English*** *as well as your self-confidence. You will review and learn the grammatical, oral and written basics. You will learn to communicate orally and in writing and you will enrich your vocabulary. You will be able to respond orally and follow a conversation.*

Prerequisites:	*Keywords:*
Level B: *No specific knowledge necessary*	*Business English*

Specific course objectives (OBJ):
OBJ 14 : *Oral expression: acquisition of vocabulary relating to working English (Business English)*
OBJ 15 : *Written expression: writing letters, messages, formats, references, abbreviations, etc.*
OBJ 16 : *The fundamentals: tense, auxiliaries, adjectives, comparatives, pronouns*

Necessary material:
The printed course purchased from the printing, data show and baffles service

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	*Job description and job satisfaction*	*3h*	*Vocab: Company departments, corporate culture vocabulary* *Gr: asking questions at a job interview*
3-4	*Letters of enquiry and applications*	*3h*	*Vocab: How to write a letter of enquiry and an email of application* *Gr: complex questions*
5-6	*Promotional activities and branding*	*3h*	*The 15 different promotional activies, the power of brands, supermarkets' own brands*
7-8	*Presenting your business idea*	*3h*	*Vocab: Structuring a presentation, signalling the parts of a presentation, making the most presentations* *Gr: modal verbs*
9	*Business meetings*	*1h30*	*Vocab: Why have meetings? purpose, benefits, importance of team discussions* *Gr: use of "too" and "enough"*
10-11	*Customer loyalty*	*3h*	*Vocab: the factors which make customers loyal to a company, words and definitions* *Gr: relative pronouns*
12-13-14	*Revision*	*4h30*	*Revision of the tenses and vocabulary of all chapters*

3- Methods evaluation & marks Distribution

Type of assessment	Yes No		Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes*	☐*No*	
DS - Supervised Duty	☒*Yes*	☒*No*	*40%*
EE - Written test (Final exam)	☒*Yes*	☐*No*	*60%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

4- Evaluation criteria (of written production)

- *Authorized documents* : ☐Yes☐ *No*
- *Search engine allowed* : ☐Yes☐ *No*
- *Criterion 1: Understanding of the subject structuring of the text: (8 points)*
- *Criterion 2: Relevance of the argument: (6 points)*
- *Criterion 3: Linguistic correction: (4 points)*
- *Criterion 4: Originality of ideas: (2 points)*

5- Web References (useful links):

- *TOIC; TOFEL*

6-Working environment (Facilities necessary for learning)

- *None*
- *…*

Course Specification

English (level C)

1. General

Coded	ENG-ABC	Level/Semester	5-6	Coefficient	1.5	Credits	2
Course	*Engineering*					Volume. H. (CI)	*21h*
Responsible	*Sawcen LAAMIRI*					Volume. H. (TP)	*0*
Teaching methods	Lecture, interactive, direct instructions,Project Based					Self study H.	*24*
Module	*Languages & Communication*					Version	*09/2023*

Course description (Course objective):
Improve your English to communicate in writing and orally in a professional Courseroom context, and prepare for the TOEIC test (Test of English for International Communication). Prepare to improve your TOEIC score in 18 hours of lessons. ***TOEIC teaching resources and methods:*** *Table, internet access. Interactivity with the teacher. Refresher, time management strategy, practical exercises, mini tests targeted to student needs, detailed corrections. Review of progress made. Tips and revision strategy before the exam.* ***Composition :*** *200 multiple choice questions (MCQ)* • *100 oral comprehension questions with audio support (4 exercises, duration 45 minutes)* • *100 written comprehension questions (3 exercises, duration 75 minutes)* ⇨ *The TOEIC is based on authentic examples taken from international professional situations (meetings, travel, telephone, etc.)* ***Results:*** *a distinct assessment of oral comprehension and written comprehension* • *a score of 5 to 495 points for each* • *a total score between 10 and 990 points*

Prerequisites:	*Keywords:*
Level C: *This course is intended for all students registered at level C in order to take the TOEIC exam*	*TOEIC, time management, oral and written*

Specific course objectives (OBJ):	
OBJ 17 :	*Prepare in the best conditions for taking the TOEIC*
OBJ 18 :	*Master the essential points of grammar and conjugation*

OBJ 19 :	*Enrich your vocabulary*
OBJ 20 :	*Improve your oral and written comprehension*

Necessary material:
The printed course purchased from the printing, data show and baffles service

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	***Detailed overview of the exam***	*3h*	• *General presentation of the test and its objectives.* • *Detailed breakdown of the test: written part/oral part.* ⇨ *Complete mock test in real time, complete and detailed correction*
3-4	***Assessment of student level and revisions***	*3h*	• *Review of current knowledge, strengths and areas for improvement.* • *Consolidation at the level of fundamental grammatical structures* ⇨ *Fill-in-the-blank exercises, multiple choice questions, reformulation exercises*
5-6-7	***Preparation for the oral comprehension part***	*4h30*	• *Listening and reconstitution of professional dialogues.* • *Improved oral comprehension.* • *Vocabulary recognition* • *Understand the story of a current event or a news item: know how to distinguish the main elements (date, place, actions, etc.).*
8-9-10	***Improvement of written comprehension***	*4h30*	• *Work on enriching everyday vocabulary* • *Work to enrich professional and commercial vocabulary.* • *Know how to read and analyze documents used in professional situations: e-mails, summaries, reports, notices, etc.*

11-12-13-14	***Final mock test***	*6h*	• *Real exam situation to evaluate and validate your progress. Detailed correction*

3- Evaluation methods & Marks Distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☒*No*	
DS – Supervised duty	☒*Yes* ☐*No*	*40%*
EE - Written test (Final exam)	☒*Yes* ☐*No*	*60%*

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

4- Evaluation criteria (of written production)

- *Authorized documents : ☐Yes☐ No*
- *Search engine allowed : ☐Yes☐ No*
- *Criterion 1: Understanding of the subject structuring of the text: (8 points)*
- *Criterion 2: Relevance of the argument: (6 points)*
- *Criterion 3: Linguistic correction: (4 points)*
- *Criterion 4: Originality of ideas: (2 points)*

5- Web References (useful links):

- *TOIC; TOFEL*

6- Working environment (Facilities necessary for learning)

- *None*
- *...*

Transversal module sheets

Course Specification

Preparing for MOS certification

1. General

Coded	**TV-401**	Level/Semester	3	Coefficient	1.5	Credits	2
Course	engineering					Volume. H. (CI)	
Responsible	Moez ZOUARI					Volumet. H. (TP)	21h
Teaching methods	interactive, direct instructions, Project Based					Self study H.	25
Module	Preparing for MOS certification					Version	09/2023

Course description (Course objective):
Acquire the basic notions necessary to create simple tables and graphs.

Prerequisites:	*Keywords:*
Know the Windows environment, excel I	*If nested, date function, text, filter database, subtotals, TCD*

Specific objectives of the course (OBJ):
OBJ 1 : *Manage complex formulas*
OBJ 2 : *Filter and conditional formatting*
OBJ 3 : *Subtotals*
OBJ 4 : *Create a pivot table*

Necessary material:
PC, Excel software (2013,2016,2019)

2- Content elements (Practical work)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	Inserting complex functions • *If nested, logical (AND, OR)*	*3*	*Mastering logical IS*

3-4	Database and complex functions • Search, Search H, • index, equiv	*3*	*Database function*
5-6	Functions • Date, date if, end. Month, day week, month, year • No., no. if, no. if together, sum. If, sum. If. together, reduced. Average, average. If	*3*	*Statistical function and date*
7-8	Filters • Automatic • Advance	*3*	*Query a database*
9-10	• Simple sort, combined sort • Subtotals	*3*	*Sort a database*
11-12	Pivot table	*3*	*Synthesize a database*
13-14	Practical Project and Synthesize	*3*	*Global evaluation*

3- Content elements (Course)

Week(s)	Activities/Content Items	No. HR	Goals
…	…	…	…
…	…	…	…
…	…	…	…

4- Evaluation methods & Marks Distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☒*No*	

DS - Supervised Duty	☐ *Yes* ☒*No*	
EE - Written test (Final exam)	☐ *Yes* ☒*No*	
EP - Practical test (TP- TP exam / MP- Mini project)	☒ *Yes* ☐ *No*	*100%*

- ***Material 100% TP : Average = 100% EP***

5- Evaluation criteria

- *Authorized documents : X Yes ☐ No*
- *Authorized search engine : ☐ Yes X No*
  - *Criterion 1: Clarity of ideas (5 points)*
  - *Criterion 2: methodological approach (5 points)*
  - *Criterion 3: innovation (5 points)*
  - *Criterion 4: presentation and mastery (5 points)*

6- Web references (useful links):

- *https://excel.developpez.com/*
- *Microsoft Press. (2019). Microsoft Office Specialist (MOS) Study Guide for Microsoft Office 365. Microsoft Press.*
- *Soper, D. (2018). MOS 2016 Study Guide for Microsoft Excel. Pearson IT Certification.*

7- Working environment (Facilities necessary for learning)

- *None*
- *...*

Course Specification

PFA (end of year project)

1. General

Coded	*TV-402*	Level/Semester	*2/S4*	Coefficient	*3*	Credits	*3*
Course	*engineer*					Volume. H. (CI)	
Responsible	*educational manager*					Volume. H. (TP)	*31.5*
Teaching methods	direct instructions , Project Based, Field Work					Self study H.	*46*
Module	*PFA (end of year project)*					Version	*09/2023*

Course description (Course objective):
• The PFA (End of Year Project) is a project which lasts one semester, which resolves a problem and which must be defended in front of a jury. • This project is an opportunity for the student to prepare themselves to know how to write a report, present their work, to highlight it and to improve their skills • PFAs start from the second semester and will end on the exam week of the second semester. • Each student is expected to contact one of these teachers for supervision • All 4th year engineering students must be called to a meeting with their educational supervisors and the head of the internship service so that they are properly oriented respectively: Pedagogically and administratively. • PFA internships must be validated at the end of a defense which is carried out following the submission of a report and an internship certificate duly completed by the company supervisor. • The teacher (school tutor) helps the student to refine the end-of-year project. He provides educational support to the student (working methodology, definition of the problem or mission, establishment of the plan, writing of the report, etc.)

Prerequisites:	*Keywords:*
…	…

Specific objectives of the course (OBJ):
OBJ 1 : *Discover the industrial world* ***OBJ 2 :*** *Solve a problem* ***OBJ 3 :*** *Writing of the report* ***OBJ 4 :***

Necessary material:
…

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	*Discover society (observation and learning)*	*6h*	Read all documents relevant to the internship related to the company and the project Learn the tools and software used in the business. Meeting with the team and supervisor Introduction to projects and internship objectives
2-4	*Define the problem and objectives*	*9h*	identification of the tasks to be accomplished. Taking inventory of all the missions to be carried out is necessary to be sure of achieving your objective on time. Observe operations in the field Make a project schedule
5-8	*The realization of the project*	*9h*	all tasks will be accomplished and the project will come to life. You have to ensure that everything goes as planned and that the objectives are achieved.
	Autonomy and responsibility		Take more responsibility in the project Work more independently Regularly take into account the progress of tasks Work collaboratively with other team members
9-11	*Evaluation of the achievement and proposal of improvement actions*	*9h*	*Study of the effectiveness of the achievement and compare with the objective* *Check the work accomplished with the supervisor*
12-14	*Close the work and propose forecasts*	*9h*	*Prepare an internship report*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
…	…	…	…
…	…	…	…
14	*Practical exam, mini-project defense, …*	*3h*	Summative evaluation

4- Evaluation methods & Marks Distribution

- *The student must submit a PFA report with a monitoring sheet signed by their educational supervisor in order to validate authorization for submission on time.*

- *In the absence of an internship certificate on the day of the defense, the jury will not accept the student and consequently the student will have a zero (unless the student brings back an authorization signed by the internship service)*
- *The evaluation is carried out by at least two members of the jury (supervisor, jury 1)*
-
- *The evaluation is also done by assigning grades on a well-detailed report which is validated by the department head and the director.*
- *Among the evaluation criteria: Oral Expression, Rigor of the approach, content of the presentation, Discussion, Behavior and attendance, structure and content of the report, etc.*

5- Evaluation criteria

Written report (5pts)
Oral Presentation (5pts)
Mastery of the subject (5pts)
Project objective (5pts)

6- Web references (useful links):

- *NONE*
- *…*

7- Working environment (Facilities necessary for learning)

- *NONE*
- *…*

Course Specification

Human Resource Management

1. General

Coded	*TV-501*	Level/Semester	*3/S5*	Coefficient	*1.5*	Credits	*3*
Course						Volume. H. (CI)	*21*
Responsible	*Ati Abderraouf*					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*24*
Module	*HRM*					Version	*09/2023*

Course description (Course objective):
At the end of this module, the engineering student must be introduced to the main concepts, methods and most common practices of HRM. Know the practices – which vary depending on the company – by which an engineer employee is recruited, evaluated, paid, etc..; Identify the "shared" role of human resources manager that an engineer who supervises a few employees quickly has; Develop critical thinking skills in relation to themes and discussions relating to the human resources function.

Prerequisites:	*Keywords:*
…	…

Specific objectives of the course (OBJ):	
OBJ 12 :	*Identify key human resources activities and decision-making*
OBJ 13 :	*Identify key human resources activities and decision-making*
OBJ 14 :	*Identify the information needed to resolve certain problems.*

Necessary material:
…

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	*Chapter I: Rise of HRM*	*3 hours*	*Identify the transition from personnel management to HRM as well as the objectives of the latter*

3-4	*Chapter II: Study and analysis of positions within the company*	*3 hours*	*Role and importance of job analysis and its link with other HRM activities, describe the methods for collecting information on positions, write a description of the required profile*
5-6	*Chapter III: Recruitment and integration*	*3 hours*	*Presentation of the recruitment process, selection and integration*
7-8	*Chapter IV: Forecast Management of Jobs and Skills*	*3 hours*	*Understand the importance and purpose of GPEC, distinguish it from workforce management, successfully manage workforce and skills*
9-10	*Chapter V: Training*	*3 hours*	*Know the links between training and other HRM activities, know the different training methods, evaluate the effectiveness of a training program*
11-12	*Chapter VI: Remuneration*	*3 hours*	*Definition and importance for employees and for the company, present remuneration systems*
13-14	*Study of practical cases*	*3 hours*	*Evaluate students' level of learning with practical cases*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
...	...	...	...
...	...	...	...
13-14	*Mini-project support, ...*	*3h*	*Summative evaluation*

4- Evaluation methods & Marks Distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	x *Yes* ☐ *No*	*20%*
DS - Supervised Duty	☐ *Yes* ☐ *No*	*20%*
EE - Written test (Final exam)	x *Yes* ☐ *No*	*60%*

EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes* ☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : x No*
- *Authorized search engine : ☐ Yes x No*
- *Criterion 1: Clarity of ideas (5 points)*
- *Criterion 2: methodological approach (5 points)*
- *Criterion 3: innovation (5 points)*
- *Criterion 4: presentation and mastery (5 points)*

6- Web references (useful links):

- *HR's role in turning around a company - Daniel Cohen and Ivan Maltcheff*
- *Henri De Camargo: General and industrial administration (1917)*
- *François Stankiewicz and François Geuze, HR Manager. Concepts for action, 2007*
- *Dave Ulrich, Human Resource Champions. The Next Agenda for Adding Value and Delivering Results, 1999*
- *Tania Saba, Simon L. Dolan, Susan E. Jackson and Randall S. Schuler, Human Resource Management, Compagon Web, edition 4, 2008, p. 71-72*

7- Working environment (Facilities necessary for learning)

NONE

Course Specification

labor law

1. General

Coded	*TV-502*	Level/Semester	*3/S5*	Coefficient	*1.5*	Credits	*2*
Course						Volume. H. (CI)	*21h*
Responsible	*Walid Chriaa*					Volume. H. (TP)	
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*24*
Module	*labor law*					Version	*09/2023*

Course description (Course objective):
Acquisition of knowledge in Labor Law (Social Law), in relation to the engineering profession and the functioning of the company. The labor contract: legal environment; hiring, working time; execution, conclusion, breach of contract; salary representation in the company

Prerequisites:	*Keywords:*
Management, business, organizational chart	*Termination, contract…*

Specific objectives of the course (OBJ):
OBJ 1 : Sources of labor law OBJ 2 : Labor inspection OBJ 3 : Determination of the employment contract OBJ 4 : Conclusion of the employment contract OBJ 5 : End of employment contract OBJ 6 : Understand the principles of international construction law. OBJ 7 : Analyze FIDIC standards and their application in construction projects. OBJ 8: Develop skills in drafting and managing international construction contracts. OBJ 9: Learn the mechanisms of arbitration and dispute resolution in an international context. OBJ 10: Apply knowledge through practical case studies and simulations.
Necessary material :
NONE

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1	*Chapter I: 1. General* *Definition* *The historical development of labor law in Tunisia* *Civil Code* *Labor Code* *Collective agreements* *Characteristics of labor law*	*1h30*	*The different official sources of Tunisian labor law*
2-3	*Chapter II: 2. Sources of labor law* *Common Sources* *International Sources* *Universal conventions* *Regional sources* *National sources* *The Constitution* *The law (labor code)* *Decrees and orders* *Doctrine* *Jurisprudence* *Clean Sources* *Spontaneous clean sources* *Own voluntary sources:* *Collective agreements* *The internal regulations* *The contract*	*3 hours*	*How to establish an employment contract that complies with different official sources*

4-5	*Chapter III: 3. LABOR INSPECTION* *Definition* *Missions* *Control* *Power of decision* *Advice* *Conciliation* *Powers of intervention of the labor inspector* *The finding of the labor inspector and its consequences* *The observations* *The notice* *The verbal procedure* *Temporary cessation of activity*	*3 hours*	*Understand the role of the work inspection as well as the types of findings and discrepancies*
6-7	*Chapter IV: 4. Determination of an employment contract* *Definition* *The distinctive criteria of the employment contract* *Work performance* *The link of subordination* *Compensation* *Distinction of employment contract from other contracts* *The mandate contract* *The company contract* *The business contract* *Types of employment contract* *The fixed-term contract (CDD)* *The permanent contract (CDI)*	*3 hours*	*The different types of employment contracts as well as the specific clauses*

8-9	*Chapter V: 5. Conclusion of the employment contract* *Obligations of the parties* *Employee obligations* *Employer obligations* *Conditions of validity of employment contract* *The basic conditions* *The defects of consent* *The capacity* *The object* *The cause* *Formal conditions* *Mandatory information* *Sanction of the rules for forming contracts* *Negotiable elements* *End of the employment contract*	*3 hours*	*Know the obligations of a contract and the elements of negotiation* *Understand the different types of end of an employment contract, the obligations and the sanctions*
10-12	**FIDIC Standards:** nalysis of key clauses in FIDIC contracts: general conditions, parties' obligations, and risk management **International Contracts**: Characteristics of contracts in the context of international construction **Arbitration and Dispute Resolution**: Introduction to international arbitration: principles, benefits, and procedures.	*4h30*	*Understand the principles of international construction law.* *Analyze FIDIC standards and their application in construction projects.* *Develop skills in drafting and managing international construction contracts.* *Learn the mechanisms of arbitration and dispute resolution in an international context.*

13-14	*Study of practical cases and presentation of personal projects*	*3 hours*	*Evaluate students' level of learning with practical cases*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
...	...	...	...
...	...	...	...
13-14	*Mini-project support, ...*	*3h*	*Summative evaluation*

4- Evaluation methods & Marks Distribution

Type of assessment	Yes No		Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	x *Yes*	☐ *No*	*20%*
DS - Supervised Duty	x *Yes*	☐ *No*	*20%*
EE - Written test (Final exam)	x *Yes*	☐ *No*	*60%*
EP - Practical test (TP- TP exam / MP- Mini project)	☐ *Yes*	☐ *No*	

- *Material 100% TP : Average = 20% CC + 80% EP*
- ***100% CI material : Average = 40% DS + 60% EE***
- *CI+TP material : Average = 20% DS + 20% EP + 60% EE*

5- Evaluation criteria

- *Authorized documents : x No*
- *Authorized search engine : ☐ Yes x No*
- *Criterion 1: Clarity of ideas (5 points)*
- *Criterion 2: methodological approach (5 points)*
- *Criterion 3: innovation (5 points)*
- *Criterion 4: presentation and mastery (5 points)*

6- Web references (useful links):

Civil Code
Labor Code
Collective agreements
FIDIC Contracts: Law and Practice"
Auteur : Ellis Baker, Ben Mellors, Scott Chalmers, Anthony Lavers
Description : Une analyse approfondie des contrats FIDIC et de leur application dans les projets de construction internationaux.

"International Construction Contracts: A Handbook"
Auteur : William Godwin
Description : Ce guide pratique explique comment rédiger et négocier des contrats de construction internationaux, y compris les aspects juridiques et les normes FIDIC.
"The Guide to Construction Arbitration"
Éditeur : Global Arbitration Review
Description : Ce livre fournit des informations sur l'arbitrage international dans le domaine de la construction, avec des études de cas et des conseils pratiques.

7- Working environment (Facilities necessary for learning)

- *NONE*

Course Specification

ESB Entrepreneurship and Small Business

1. General

Coded	*TV-503*	Level	*3/S5*	Coefficient	*1.5*	Credits	*2*
Course	*Engineering*					Volume. H. (CI)	*21*
Option	*Moez ZOUARI*					Volume. H. (TP)	*0*
Teaching methods	Lecture, interactive, direct instructions					Self study H.	*28*
Module	*ESB*					Version	*09/2023*

Course description (Course objective):
The objective of the course is to master small business entrepreneurial skills and understand its different functions. *The ESB certification is designed to test and validate fundamental concepts and knowledge in entrepreneurship and small business management. These fundamental concepts include* - *Entrepreneurship;* - *Recognize and evaluate opportunities;* - *Plan, start and operate a business;* - *Marketing and sales;* - *and finance and business financing.*

Prerequisites:	*Keywords :*
None	*Entrepreneurship, management, business environment, accounting, commerce, finance*

Specific objectives of the course (OBJ):
OBJ 1 : *Identify the characteristics of entrepreneurs and as well as the risks, benefits, opportunities and disadvantages of being an entrepreneur*
OBJ 2 : *Identify the advantages and disadvantages of different types of opportunities*
OBJ 3 : *Identify the objectives, value of a business plan and the appropriate legal structure*
OBJ 4 : *Identify the advantages and disadvantages of various sources of startup financing*

OBJ 5 : *Identify business operations: human capital needs, intellectual property issues, standard operating procedures, etc.* ***OBJ 6 :*** *Develop a sales strategy, identify and analyze the costs/benefits of finding customers, identify how to retain customers, and determine the value and methods of communication.* ***OBJ 7 :*** *Interpret basic financial statements, identify and analyze cash flows, and identify the company's break-even point.*

Necessary material :
None

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1.2	***The entrepreneur:*** - *Identify the characteristics of entrepreneurs* - *Given a scenario including a self-assessment result, identify the strengths, weaknesses, and risk tolerance the self-assessment identifies and how to compensate with services* - *Given a scenario, recognize a business opportunity* - *Identify the risks, benefits, opportunities and disadvantages of being an entrepreneur*	*3h*	*OBJ 1*
3.4	***Opportunity recognition :*** - *Identify the advantages and disadvantages of different types of opportunities (for example, starting a new business, purchasing an existing business, and purchasing a franchise)* - *Given a scenario, analyze the demand for the good or service and opportunities in an environment* - *Given a scenario, identify customers or potential customers for a business* - *Given a scenario, recognize a value proposition*	*3h*	*OBJ 2*

5.6	***Start a business :*** - *Identify the objectives and value of a business plan* - *Identify the appropriate legal structure, advantages and disadvantages for different legal structures for a business* - *Given a scenario, identify different types of licenses and regulations needed* - *Identify the pros and cons of various sources of startup funding: equity (friends/family, angel investors, venture capital), debt (bank, credit cards, personal loans), and grants (government, foundation, business)* - *In a given scenario, identify the support available to the business at the local, state, and federal levels* - *Identify ethical practices and social responsibilities of a company* - *Identify potential exit strategies for a business*	3h	OBJ 3 OBJ 4
7.8	***Commercial operations :*** - *Based on a scenario, identify key positions and human capital needs (including compensation and benefits)* - *Given a scenario, determine if the work can be done by the owner or if employees or service providers are needed* - *In a given scenario, identify the required taxes* - *Using a scenario, identify intellectual property issues related to trademarks, copyrights and patents.* - *In a given scenario, identify standard operating procedures (e.g., setup, conduct, internal controls, segregation of duties)* - *Based on a scenario, identify the factors that led to sustainability*	3h	OBJ 5
9.10	***Marketing and sales:*** - *Based on a scenario, develop a sales strategy and identify the characteristics of a successful sale* - *Given a scenario, identify and analyze the costs/benefits of finding customers* - *Based on a scenario, identify how to retain customers and develop a relationship with loyal customers* - *Based on a scenario, determine the value and methods of communication, including: websites, brochures, social media and advertising.*	3h	OBJ 6
11.14	***Financial management :***	6h	OBJ 7

	- *Given a scenario, interpret basic financial statements such as income statements and balance sheets* - *Using a scenario, identify the factors that influence credit ratings and the importance of a positive credit rating* - *From a list of expenses, identify which ones are fixed or variable* - *Given a scenario, identify the factors that impact the price for the customer* - *Given a scenario, identify and analyze cash flows, including accounts receivable, accounts payable, inventory and debt.* - *Given a scenario, create a cash budget* - *Given a scenario, identify the company's break-even point*		

3- Evaluation methods & Marks Distribution

Type of assessment	Yes No	Tx Weighting
CC - Continuous assessment (Test/Quiz, Presentation, Report, etc.)	☐ *Yes* ☒ *No*	-
DS - Supervised Duty	☐ *Yes* ☒ *No*	-
EE - Written test	☒ *Yes* ☐ *No*	*50%*
EC – Certification Exam	☒ *Yes* ☐ *No*	*50%*

4- Evaluation criteria

- *Authorized documents* : ☐ *Yes* ☒ *No*
- *Authorized search engine* : ☐ *Yes* ☒ *No*

- *Criterion 1: The entrepreneur (4 points)*
- *Criterion 2: Recognition of opportunities (3 points)*
- *Criterion 3: Start a business (4 points)*
- *Criterion 4: Commercial operations (3 points)*
- *Criterion 5: Marketing and sales (3 points)*
- *Criterion 6: Financial management (3 points)*

5- Web references (useful links):

- *ESB overview, https://certiport.pearsonvue.com/Certifications/ESB/Certification/Overview*
- *Exam Objectives for ESB, C:\Users\LENOVO\Downloads\ESB OD Original 0221.pdf*
- Scarborough, N. M. (2016). Effective Small Business Management: An Entrepreneurial Approach (11th ed.). Pearson.
- Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2017). Entrepreneurship (10th ed.). McGraw-Hill Education.

6- Working environment (Facilities necessary for learning)

- *None*

subject Sheets Projects and internships

Course of Internships at EPI

Importance of Internships:

Internships in companies are an integral part of the EPI Group's training.

These internships in companies are mandatory for obtaining the diploma.

Also, the EPI Group pays particular attention to their progress.

During these internships, students develop their personal qualities, learn to work in a team and carry out projects.

Professional internships must be validated at the end of a defense.

Types of Internships:

Internships in companies are of three types:

- **Introductory Internship**: they concern 3rd year students
    - ✓ Objective: To give students the opportunity to discover the professional world and join the company.
    - ✓ Minimum duration: 1 month
- **Professional internships** (design and/or implementation of projects linked to the specialty): they concern 4th year students
    - ✓ Objective: The student is expected to carry out the design and/or implementation of projects related to his specialty
    - ✓ Minimum duration: 1 month
- **PFE internships**: they concern 5th year students
    - ✓ Objective: Implementation of all the skills acquired during schooling to carry out a project allowing one to project oneself into the professional world
    - ✓ Minimum duration: 16 weeks

The EPI Group supports its students during these internships and provides them with the Internship Service for coordination with the different departments and host companies (choice, validation, etc.).

Evaluation of the Internships:

The internship results in the writing of a report, which must be presented before a jury. This jury must be composed of at least two members:

- A president who must be a teacher from the EPI Group.
- An examiner: who must be a teacher from the EPI Group.
- The university supervisor who must be a teacher from the EPI Group.
- An internship tutor who must represent the host structure.

All internships must be validated at the end of a defense.

For this, each student is required to submit to the internship service:

- A connection form (to download from the “Internship forms” menu on our website episup.com)
- An internship certificate obtained from the company and duly completed and signed.
- Supervision monitoring sheet duly completed by the educational supervisor
- Company appreciation form: duly completed by the professional supervisor
- The internship report bearing the EPI Group cover page (to be downloaded from the “Internship forms” menu) in at least two copies (depending on the number of jury members) and one scanned copy.

Course Specification

*Projects and internships (PFE, Professional internships, Introductory Internship) * PFE*

1. General

Coded	Pro- 5 2 03	Level/Semester	*3/S6*	Coefficient	*10*	Credits	*24*
Course	*Engineering course*					Flight. H. (CI)	
responsible	Internships department					Flight. H. (TP)	
Teaching methods	direct instructions,Project Based, Field Work					Self study H.	*700*
Module	*PFE*					Version	*09/2023*

Course description (Course objective):
This involves the implementation of all the skills acquired during schooling to carry out a project, generally proposed by a company, allowing one to project oneself into the professional world. The student works full-time within the company and is supervised by a teacher. During an End of Study Project (PFE), the student is led to develop a problem based on a specific professional situation. The main objective of this last internship is to affirm the skills of our future engineers and to prepare them effectively for their entry into professional life. The subject of the PFE internship generally leads the future engineer to encounter challenges and allows him to learn to act accordingly.

Prerequisites:	*Keywords :*
…	…

Specific objectives of the course (OBJ):
OBJ 1 : The PFE ideally allows the intern to carry out a project from A to Z… **OBJ 2 :** Go through all the stages necessary for its realization, from the study of specifications to final delivery **OBJ 3 :** Participate in technical studies: definition of problems, acquisition, compilation and analysis of data, formulation of hypotheses and recommendations; **OBJ 4 :** Put the student in the position of an engineer, **OBJ 5 :** Refine their first career orientations, **OBJ 6 :** Measure the role of the company's different engineers, **OBJ 7 :** Discover the different functions and their relationships, **OBJ 8 :** Write an end-of-studies report.

Necessary material :
…

2- Content elements (Course)

Week(s)	Chapters/Content Items	No. HR	Goals
1-2	*Discover society (observation and learning)*		Read all documents relevant to the internship related to the company and the project Learn the tools and software used in the business. Meeting with the team and supervisor Introduction to projects and internship objectives
3-4	Establishing project objectives	…	Clearly define the objectives to be achieved with the project. Observe operations in the field Make a project schedule Establish a Problem
4-5	Project planning and design	…	project delivery , including specific steps to follow and resources required. Design potential solutions to meet project objectives
5-7	Data collection and situation analysis		Collect relevant data necessary to carry out the project. Analyze data to understand the causes of the problem using analytics tools
7-8	Project implementation		Implement the solutions designed within the project framework .
8-9	*Autonomy and responsibility*		Take more responsibility in the project Work more independently Regularly take into account the progress of tasks Work collaboratively with other team members
9-12	Testing and validation		Test the developed solutions and ensure that they meet the specifications and needs of the project. Validate the results obtained with the internship supervisor or the team responsible for the project in the company.
12-14	*Close the work and propose forecasts*		*Prepare an internship report*

3- Content elements (Practical work)

Week(s)	Activities/Content Items	No. HR	Goals
…	…	…	…
…	…	…	…
12	*Practical exam, mini-project defense, …*	*3h*	*Summative evaluation*

4- Evaluation methods & Marks Distribution

- *The student must submit a PFE report with a monitoring sheet signed by their educational supervisor in order to validate authorization for submission on time.*
- *In the absence of an internship certificate on the day of the defense, the jury will not accept the student and consequently the student will have a zero (unless the student brings back an authorization signed by the internship service)*
- *The evaluation is carried out by at least three members of the jury (supervisor, president of the jury and rapporteur)*
- *The evaluation is also done by assigning grades on a well-detailed report which is validated by the department head and the director.*
- *Among the evaluation criteria: Oral Expression, Rigor of the approach, content of the presentation, Discussion, Behavior and attendance, structure and content of the report, etc.*

5- Evaluation criteria

Criteria	
Oral Expression: - Ability to keep the audience attentive - Judicious use and quality of transparencies. - Vocabulary, use of appropriate technical terms - Respect the planned time.	/04
Steps : - Rigor of the approach: choice, tools, method and synthesis	/04
Content of the presentation: - Level of know-how, technicality... - Personal work carried out. - Presentation of objectives achieved	/08
Discussion : - Mastery of aspects related to the subject, justifications, etc.	/04
Behavior, Attendance, Punctuality and Motivation	.. /04
Personal contribution and initiative	.. /06
Scientific and technological knowledge	.. /05
Level of know-how , technicality, creativity and functionality	.. /05
Report Structure -Acknowledgements, summary, introduction, presentation of the company, specifications, technical content, conclusion - Balanced ratio (Volume) - Clear and progressive presentation of information - Reasonable use and definition of technical terms, standardization	.. /06
Content of the Report - Presentation of the work requested (specifications) then of the entire made work. - Technical content - Meets standards -Importance of personal work (volume and level) - Justification for the choice of solutions adopted. - Comparison of the objectives achieved with the content of the specifications - Appendices, Bibliographies	.. /08
Presentation of the report -Pagination, layout -Spelling, grammar, style. - Clarity and quality of figures, diagrams, etc.	.. /06

6- Web references (useful links):

- *Author, Title, URL, Year*
- *...*

7- Working environment (Facilities necessary for learning)

- *None*
- *...*

Professional internships

Coded	Pro- 5 2 02	Level/Semester	*3/S6*	Coefficient	*10*	Credits	*3*
Course	*Engineering course*					Flight. H. (CI)	
responsible	Internships department					Flight. H. (TP)	
Teaching methods	direct instructions,Project Based, Field Work					Self study H.	*75*
Module	Professional internships					Version	*09/2023*

Course description (Course objective):
During his professional internship, the student, who has achieved his 4th year succesfully, must complete a practical case whose theme depends on his specialization The student works full-time within the company but is not supervised by a teacher. It's a period of practical training or work experience undertaken by a student in a professional setting relevant to his field of study and career goals. It provides the intern with the opportunity to apply theoretical knowledge gained in academic settings to real-world scenarios, gaining practical skills and insights into their chosen profession. Interns may also have the opportunity to network with professionals in their field, build valuable connections, and sometimes even secure PFE opportunities upon completion of the internship.

Prerequisites:	*Keywords :*
…	…

Specific objectives of the course (OBJ):
OBJ 1 : Providing students with practical, real-world experience in their field of study or desired career path. **OBJ 2 :** Develop and refine technical skills, soft skills, and industry-specific competencies necessary for future success in the profession. **OBJ 3 :** Receive constructive feedback from supervisors and mentors to identify strengths, areas for improvement, and opportunities for further growth. **OBJ 4 :** Gain insights into the expectations and realities of the workforce, facilitating a smoother transition from student life to professional employment post-graduation. **OBJ 5 :** Write a professional internship report.

Evaluation methods & Marks Distribution

- *The student must submit a professional internship report with a Internship certificate and Company appreciation form duly completed and signed in order to validate authorization for submission on time.*
- *In the absence of an internship certificate on the day of the defense, the jury will not accept the student and consequently the student will have a zero (unless the student brings back an authorization signed by the internship service)*
- *The evaluation is carried out by at two members of the jury.*

- *The evaluation is also done by assigning grades on a well-detailed report which is validated by the department head and the director.*
- *Among the evaluation criteria: Oral Expression, Rigor of the approach, content of the presentation, Discussion, Behavior and attendance, structure and content of the report, etc.*

Introductory Internship

Coded	Pro- 5 2 01	Level/Semester	*3/S6*	Coefficient	*10*	Credits	*3*
Course	*Engineering course*					Flight. H. (CI)	
responsible	Internships department					Flight. H. (TP)	
Teaching methods	direct instructions,Project Based, Field Work					Self study H.	*75*
Module	*Introductory Internship*					Version	*09/2023*

Course description (Course objective):
It is an internship for discovering the company the student spend time observing and shadowing experienced professionals within various departments or teams. This allows them to gain insights into different aspects of the organization's operations and understand the roles and responsibilities of various team members. As the internship progresses, the student is gradually given more opportunities to participate in hands-on tasks and projects under the guidance and supervision of mentors or supervisors. These tasks may be relatively simple or routine at first but gradually increase in complexity as the student gains confidence and demonstrates competence.

Prerequisites:	*Keywords :*
...	...

Specific objectives of the course (OBJ):
OBJ 1 : Help students explore different career paths within their field of study or industry by exposing them to various departments, roles, and responsibilities ***OBJ 2 :*** Provide students with opportunities to develop fundamental skills relevant to their field, such as communication, teamwork, problem-solving, and time management **OBJ 3 :** Offer students practical, hands-on experience through tasks, projects, and assignments that contribute to the organization's goals and objectives. **OBJ 4 :** Facilitate networking opportunities for students to connect with professionals in their field, **OBJ 5 :** Prepare students for future internships or employment opportunities by equipping them with essential skills, experiences, and insights into the professional world.