ULT Mechatronics Engineering

Subjects Modules for S4

Semester 2 Year 2

U4.1: Electronics Electrotechnics 4 EE 4

U4.1.1: Image Processing

Module designation	**Electronics Electrotechnics 4 EE 4**
Module level, if applicable	Year 2, Semester 2
Code, if applicable	U4.1
Subtitle, if applicable	
Courses, if applicable	Image Processing
Semester(s) in which the module is taught	Semester 4
Person responsible for the module	Dr Emna RABHI
Lecturer	Mme Salma BEN SAID
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	Lecture, 15 hours Classroom Lecture/ Semester 6 hours Workshop in Lab
Workload	Total 42hours/ Semester (21 hours of Self Study)
Credit points	1.5
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Matlab, Digital & Analog Signal Processing
Module objectives/intended learning outcomes	**Objectives:** 1. Introduction to the basic concepts of image processing 2. Study of the different types of image transformation 3. Study of image enhancement and restoration techniques 4. Introduction to mathematical morphology 5. Study of image segmentation techniques.

Content	**Chapter 1 General Introduction** 1. Colorimetry elements 2. Colour representation systems 3. Digital representation of an image 4. Image formats 5. Image processing and analysis process **Chapter 2 Image transformation** 1. One-off transformations 2. Neighbourhood transformations 3. Fourier transformation **Chapter 3 Images Enhancement and restoration** 1. Enhancement techniques 2. Contrast stretch \ dynamics cropping 3. Histogram equalization 4. Histogram specification 5. Enhancement by accentuating details 6. Enhancement by spectral filtering 7. Enhancement by homomorphic filtering 8. Colour enhancement 9. Restoration techniques 10. A priori knowledge 11. A posteriori knowledge 12. Filtering **Workshops using Matlab:** TP1: Manipulation and transformation of digital images TP2: Image transformations TP3: Histogram and image enhancement TP4: Restoration by Filtering
Study and examination requirements and forms of examination	Written Mid-Term Exam (25%) + Workshop Exam (25%)+ Written Final Exam (50%)
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Video projection
Reading list	- R. C. GONZALEZ, R. E. WOODS, DIGITAL IMAGE PROCESSING, PRENTICE HALL - G. INTRODUCTION AU TRAITEMENT D'IMAGES - SIMULATION SOUS MATLAB, HERMES - RAFAEL C. GONZALEZ, RICHARD E. WOODS, STEVEN L. EDDINS, DIGITAL IMAGE PROCESSING USING MATLAB, MCGRAW HILL EDUCATION

U4.1: Electronics Electrotechnics 4: EE 4

U4.1.2: Electrical Machine

Module designation	**Electronics Electrotechnics 4: EE 4**
Module level, if applicable	Year 2, Semester 2
Code, if applicable	U4.1
Subtitle, if applicable	
Courses, if applicable	**Electrical Machine**
Semester(s) in which the module is taught	Semester 4
Person responsible for the module	Dr Emna RABHI
Lecturer	Mme Saloua Ben SAID
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	Lecture, 21 hours Classroom Lecture/ Semester 21 hours for Workshop in Lab / semester
Workload	Total 84 hours/ Semester (42 hours of Self Study)
Credit points	3
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Electrotechnics
Module objectives/intended learning outcomes	**Objectives:** 1. Understand Electrical Machine classification, operation, and application area. 2. Hands practices in the lab in order to operate electrical machine; 3. Learn how to collect data and create necessary plots 4. Choose the appropriate electric motors.

Content	**Chapter 1. Electrical Machines** 1. General introduction 2. General laws of electromechanical conversion **Chapter 2. Direct Current DC machine** 1. Description 2. Working principle 3. Equivalent electrical circuit diagram 4. Power conversion 5. The different types of direct current machines 6. Power Equilibrium 7. Choice of MCCs **Chapter 3. Universal Electrical Motor** 1. Description 2. Working principle **Chapter 4. Brushless Motor** 1. Description 2. Working principle **Chapter 5. Asynchronous Motor** 1. Description 2. Working principle 3. Connection 4. Nameplate 5. Link with the network 6. Characteristic curves 7. Types of start-up: Direct, Star Delta, stator, autotransformer **Chapter 6. Synchronous Motor** 1. Description 2. Working principle **Practical workshop** **TP1:** The single-phase transformer *Objectives:* Present a general method for determining the parameters of the equivalent diagram of a single-phase transformer **TP2:** The direct current motor. *Objectives:* -Study the direct current DC motor respectively with series, parallel (shunt), compound and independent excitation. -Plot the electrical and electromagnetic characteristics of an MCC. **TP3:** The three-phase asynchronous motor *Objectives:* - Study the nameplate of the three-phase asynchronous motor.

	- Study the operation of a three-phase asynchronous motor with no load and load. - Perform electrical measurements of voltage, current and power - Perform measurements of speed and torque. **TP4:** Three-phase synchronous alternator *Objectives:* -Decode a nameplate -Realize the assemblies allowing to carry out the tests of Synchronous Machine -Interpret and use the measurements **Recommendations & Regulations:** Students will need to follow **Recommendations & Regulations** of Electrical machine labs. A preparation is required before each workshop session in order to ensure the smooth running of the planned activities. *Equipment Available in the Lab:* 1. Power supply units: DC, single-phase AC, three-phase AC, 2. Measuring devices (voltmeters, ammeter, multimeters, power meters, Tachometer). 3. Three-phase electrical loads. 4. Connection cables, 5. Electrical machine (DC machine, synchronous machine, asynchronous machine, alternators) 6. Mechanical load (Electrodynamometer or asynchronous alternator load). 2. Data acquisition interface card connected to a computer.
Study and examination requirements and forms of examination	Written Mid-Term Exam (25%) + Practical Workshop(25%)+Written Final Exam (50%)
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Video projection
Reading list	MACHINES ÉLECTRIQUES; CLAUDE CHEVASSU (2012) MOTEURS ELECTRIQUES INDUSTRIELS. PIERRE MAYÈ ; DUNOD, 2005.

U4.1: Electronics Electrotechnics 4: EE 4

U4.1.3: Operational Research

Module designation	Electronics Electrotechnics 4: EE 4
Module level, if applicable	Year 2 , Semester 2
Code, if applicable	U4.1
Subtitle, if applicable	
Courses, if applicable	Operational Research
Semester(s) in which the module is taught	Semester 4
Person responsible for the module	Dr Emna RABHI
Lecturer	Mme Meriem Mejri
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	12 hours Classroom Lecture/ Semester 9 hours for practical Workshop
Workload	Total 42hours/ Semester (21 hours of Self Study)
Credit points	1.5
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Linear Algebra
Module objectives/intended learning outcomes	**Objectives:** 1. Introduce students to optimization theory and decision support. 2. Build mathematical models for complex decision problems 3. Solve mathematical models using an algebraic technique

Content	**Chapter 1. Linear Programming** 1. General form of a Linear Program 2. Canonical and standard form of a Linear Program 3. Matrix Writing of a Linear Program 4. Modelling a Problem 5. Application exercises **Chapter 2. Resolution of a Linear Program:** 1. Graphic Method 2. Simplex method 3. Application exercises **Chapter 3. Extension of Linear Programming: Duality** 1. Dual Linear Problem 2. Production problem 3. Mixing problem 4. Properties of duality 5. Application exercises **Practical Workshop in Lab** I- Linear programming 1- The conditions and stages of formulation of a PL 2- Examples II- The graphic method (EXCEL) 1- Graphical representation of the constraints 2- Graphic representation of the objective function 3- Search for the optimal solution 4- Examples III- Use of resolution software and analysis of the results 1- EXCEL solver a) Installation of the 'Solver' add-in b) Preparation of the Excel sheet c) Description of the Solver window d) Solver settings e) Exercises 2- Optimization package: CPLEX a) Initialization b) The OPL language (Optimization Programming Language) c) Creation and resolution of a simple model - Creation of the project and the model - OPL syntax - Resolution - Exercises -
Study and examination requirements and forms of examination	Written Mid-Term Exam (25%) + Practical Workshop(25%)+Written Final Exam (50%)

Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Video projection
Reading list	1. Problèmes résolus de recherche opérationnelle ; Yves Nobert, Roch Ouellet, Régis Parent (1999) 2. Précis de recherche opérationnelle ; Robert Faure, Bernard Lemaire, Christophe Picouleau (2014) 3. Programmation Linéaire ; Eric Jacquet-Lagreze (1998) 4. Optimisation Discrète ; Alain Billionnet (2007) ***5.*** *IBM, IBM ILOG CPLEX Optimization Studio Getting Started with the IDE, gso plide.pdf* 6. *IBM, IBM Knowledge Center, Utilisation d'IBM ILOG Script for OPL, opl_ide_script*

U4.2: Mechanics 4

U4.2.1: Continuum Mechanics

Module designation	**Mechanics 4**
Module level, if applicable	Year 2, Semester 2
Code, if applicable	U4.2
Subtitle, if applicable	
Courses, if applicable	Continuum Mechanics
Semester(s) in which the module is taught	Semester 4
Person responsible for the module	Dr Emna RABHI
Lecturer	Dr. Adel Hamdi
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	Lecture, 21 hours Classroom Lecture/ Semester
Workload	Total 42hours/ Semester (9 hours of Self Study)
Credit points	1
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Mathematics, Coordinate transform, mechanical testing, Resistance of Material
Module objectives/intended learning outcomes	**Objectives:** 1- Understand a Continuum 2- Learn about deformation & displacement 3- Understand Internal Efforts in a Continuum environment 4- Master calculation methodology through applications **Course Outcomes:** After completing this Course, Students should 1. Be familiar with linear vector spaces relevant to continuum mechanics and able to perform vector and tensor manipulations 2. Be able to describe motion, deformation and forces in a continuum; 3. Be able to derive equations of motion and conservation laws for a continuum ; 4. Be able to solve simple boundary value problems

Content	**Chapter I- Introduction:** 1- Concept of a Continuum 2- Continuum hypothesis and material particle **Chapter II- Study of the Deformations:** 1- Kinematics of Continuum 2- Lagrangian description 3- Displacement - Small disturbance hypothesis a- Linearized strain tensor- Principal strains b- Calculation of displacement *Tutorial 1* **Chapter III-Internal Efforts in a Continuum environment:** 1- Reminder on external forces - definition of internal forces 2- Stress vector and stress tensor 3- Particular stress states 4- Balance equation *Tutorial 2* **Chapter IV- Equilibrium problems in isotropic linear elasticity:** 1-Linearized problems of the elasticity balance a- Quasi-static formulation. b- Isotropic linear constitutive law: Coefficients of elasticity *Tutorial 3*
Study and examination requirements and forms of examination	Written Mid-Term Exam (40%) + Written Final Exam (60%)
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Video projection
Reading list	[1] P. Germain : Mécanique des Milieux Continus. Masson, Paris, 1962. 1, 3, 8 [2] P. Germain : Cours de Mécanique des Milieux Continus, Tome 1 : Théorie Générale. [3] S. Timoshenko et J. Goodier : Théorie de l'élasticité. Béranger, Paris, [4] M. Roy : Mécanique, tome II : Milieux Continus. Dunod, Paris, 1966. 11961.Masson, Paris, 1973. 1, 3, 5 [5] G. Gontier : Mécanique des Milieux Déformables. Dunod, Paris, 1969

U4.2: Mechanics 4

U4.2.2: Pneumatic & Hydraulic

Module designation	**Mechanics 4**
Module level, if applicable	Year 2, Semester 2
Code, if applicable	U4.2
Subtitle, if applicable	
Courses, if applicable	Pneumatic & Hydraulic
Semester(s) in which the module is taught	Semester 4
Person responsible for the module	Dr Emna RABHI
Lecturer	Dr. Mohamed Nizar BETTAIEB
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	Lecture, 21 hours Classroom Lecture/ Semester
Workload	Total 51 hours/ Semester (30 hours of Self Study)
Credit points	2
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Sensors-actuators, Fluid Mechanics
Module objectives/intended learning outcomes	**Objectives:** 1- Understand all steps and requirement for pneumatic installation 2- Understand all steps and requirement for pneumatic installation 3- Learn how to Identify and design the both installations

Content	**CHAPTER 1: INDUSTRIAL PNEUMATIC TECHNOLOGY** 1. Compressed air 1.1 Introduction 1.2 Properties 1.3 Characteristics 2. Compressed air plant 2.1 Compressors 2.2 Air conditioning 3. Pneumatic cylinders 3.1 Construction and operating principle of a jack 3.2 Types of standard and special cylinders 4. Pneumatic distributors 4.1 Role of the distributor 4.2 Principle of operation 4.3 Designation principle 4.4 Schematization rules 5. Characteristics and sizing 5.1 Cylinder speed adjustment 5.1.2 Sizing and choice of cylinders 5.1.3 Sizing of a distributor and piping 6. Study and sizing of examples of electro-pneumatic circuits **CHAPTER 2: INDUSTRIAL HYDRAULIC TECHNOLOGY** 1. Theory of hydraulics 2. Hydraulic fluids and pressure drop 3. Basic hydraulic circuit 4. Hydraulic unit 5. Hydraulic pumps (technology and sizing) 6. Flow valves 7. Pressure relief valves 8. Pressure accumulators (technology and sizing) 9. Distributors and cylinders (technology and sizing) 10. Hydraulic motors *Applications: Sizing of electro-pneumatic and electro-hydraulic circuits*
Study and examination requirements and forms of examination	Written Mid-Term Exam (40%) + Written Final Exam (60%)
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Video projection

Reading list	- INDUSTRIES ET TECHNIQUES : MECANISMES HYDRAULIQUES ET PNEUMATIQUES, J. FAISANDIER EDITION DUNOD. - SCIENCES INDUSTRIELLES: HYDROSTATIQUE 1, F. ESNAULT ET P. BENETEAU, EDITION ELLIPSES - SCIENCES INDUSTRIELLES: HYDROSTATIQUE 2, F. ESNAULT ET P. BENETEAU, EDITION ELLIPSES - GUIDE DES SCIENCES ET TECHNOLOGIES INDUSTRIELLES, JEAN-LOUIS FANCHAN, EDITION NATHAN 1994. - LA PNEUMATIQUE DANS LES SYSTEMES AUTOMATISES DE PRODUCTIONS, S. MORENO, E. PEULOT , EDITION CASTEILLA 2001

U4.2: Mechanics 4

U4.2.3: CAM Computer Aided Manufacturing using CNC

Module designation	**Mechanics 4**
Module level, if applicable	Year 2, Semester 2
Code, if applicable	U4.5
Subtitle, if applicable	
Courses, if applicable	CAM Computer Aided Manufacturing using CNC
Semester(s) in which the module is taught	Semester 4
Person responsible for the module	Dr Emna RABHI
Lecturer	M Fadhel BEN FARHAT
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	21 hours for Workshop in Lab/ semester
Workload	Total 30 hours/ Semester (9 hours of Self Study)
Credit points	1
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	CAD, Technical Drawing, Manufacturing
Module objectives/intended learning outcomes	**Objectives:** The student will be able to: General skills : Understand the Computer Aided Manufacturing CAM Chain Specific skills : - Understand the basics of MOCN programming - Understand the basic functions of a CAD / CAM platform. - 2D machining. - 3D machining

Content	**Exercise 1**: Numerical Control Machine Tools CNC Vector Chain **Exercise 2:** Point by point programming **Exercise 3:** Adjustment of tools and declarations of origins **Exercise 4:** Machining 2 and a half axes on a milling center. **Exercise 5:** Use of a CAD / CAM platform to generate tool paths (interfaced CAD / CAM process / Integrated CAD / CAM process) / simple machining **Exercise 6:** Use of a CAD / CAM platform to generate tool paths / 3D machining **Exercise 7:** Transfer and execution of program generated by CAM, on a milling center.
Study and examination requirements and forms of examination	Continuous Assessment 40% (Report for each workshop required) +Semester Workshop Exam 60 %
Media employed	Workshop Handbook in Lab Video projection
Reading list	- LEAN MANAGEMENT: OUTILS, METHODES, RETOURS D'EXPERIENCES, QUESTIONS/, CHRISTIAN HOFFMAN, 2012 - SYSTEME LEAN: PENSER L'ENTREPRISE AU PLUS JUSTE, JAMES P. WOMACK, DANIEL T. JONES, - LES BASIQUES DU LEAN MANUFACTURING: DANS LES PMI ET ATELIERS TECHNOLOGIQUES, PIERRE BEDRY, 2009

U4.2: Mechanics 4

U4.2.4: Vibrations Analysis

Module designation	**Mechanics 4**
Module level, if applicable	Year 2, Semester 2
Code, if applicable	U4.2
Subtitle, if applicable	
Courses, if applicable	Vibrations Analysis
Semester(s) in which the module is taught	Semester 4
Person responsible for the module	Dr Emna RABHI
Lecturer	Dr Adel Hamdi
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	Lecture, 21 hours Classroom Lecture/ Semester
Workload	Total 51 hours/ Semester (30 hours of Self Study)
Credit points	2
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Math, Solid Mechanics, Resistance of Material, Electronics, Fluid Mechanics
Module objectives/intended learning outcomes	**Objectives:** **Part 1:** 1. Understanding Structure Vibration Modelling techniques 2. Learn how to calculate the mechanical system natural frequencies and the vibratory response 3. Understand Analysis methods of the mechanical system vibratory behaviour **Part2:** 1. Understand the machines dynamic Modelling process 2. Learn how to develop homologous circuits by mechatronic analogy 3. Understand the dynamic behaviour analysis of a complex machine

Content	**Chapter I- Introduction to Mechanical Vibrations** 1- Problems induced by vibrations 2- Quantification of a vibratory level 3- Elements of a vibrating mechanical system 4- Reminders on the motion system equations **Chapter II- Vibrations of discrete systems with 1 degree of freedom** 1- Free vibrations 2- Forced vibrations 3- Vibratory behaviour of damped systems **Chapter III- Vibrations of discrete systems with several degrees of freedom** 1- Vibrations of systems with 2 degrees of freedom a- Coupling by stiffness b- Inertial coupling c- Matrix writing d- Solving the equations of motion for the cases of a conservative system and a dissipative system e- Methodology of calculation of the clean modes 2- Generalization to systems with n degrees of freedom a- Establishment of the equations of motion of a system with n degrees of freedom b- Resolution by the modal method: response of a free system **Chapter IV- Continuous Systems Vibration** 1- Motion of beams Equations 2- Calculation of the Eigen modes ***Application 1:*** Vibration damper ***Application 2:*** Study of a vehicle suspension vibratory behaviour *Application: Modelling and analysis of the dynamic behaviour of a direct current machine*
Study and examination requirements and forms of examination	Written Mid-Term Exam (40%) + Written Final Exam (60%)
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Video projection
Reading list	- B. P. Lathi, « Linear Systems and Signals », Berkeley-Cambridge Press, 1992. - A. Maalej, « Analyse des systèmes dynamiques », 1996

U4.3: Mechatronics Elements 4

U4.3.1: Robot Programming

Module designation	**Mechatronics Elements 4**
Module level, if applicable	Year 2, Semester 2
Code, if applicable	U4.3
Subtitle, if applicable	
Courses, if applicable	Robot Programming
Semester(s) in which the module is taught	Semester 4
Person responsible for the module	Dr Emna RABHI
Lecturer	Melle Latifa Neffati
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	Lecture, 21 hours Classroom Lecture/ Semester 21 hours for Project in Lab/ semester
Workload	Total 77hours/ Semester (35 hours of Self Study)
Credit points	3
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	-Linear algebra (Matrices and vectors multiplication, …) -Calculus (Integrals, derivatives, …) -Matlab (Basic programming skills)
Module objectives/intended learning outcomes	**Objectives:** 1. Program and Control a Robot manipulator with different strategies 2. Hands-on Practices on some projects in Lab

Content	**Part 1 : Lecture** **Chapter 1- Trajectory generation** 1. Introduction 2. General Considerations In Path Description And Generation 3. Joint-Space Schemes 4. Cartesian-Space Schemes 5. Geometric Problems With Cartesian Paths 6. Path Generation At Run Time 7. Description Of Paths With A Robot Programming Language 8. Planning Paths When Using The Dynamic Model 9. Collision-Free Path Planning **Chapter 2- Linear control of manipulator** 1. Introduction 2. Feedback And Closed-Loop Control 3. Second-Order Linear Systems 4. Control Of Second-Order Systems 5. Control-Law Partitioning 6. Trajectory-Following Control 7. Disturbance Rejection 8. Continuous Vs. Discrete Time Control 9. Modeling And Control Of A Single Joint **Part 2: Applied projects** **Project 1-**Dynamic modelling and 3D animation of an inverted pendulum. **Project 2**: Dynamic modelling and 3D animation of a bouncing ball. **Project 3**: Dynamic modelling and 3D animation of the car suspension. **Project 4**: Dynamic modelling and 3D animation of the pendulum carriage suspension. **Project 5**: Switching from CATIA and SOLIDWORKS to Matlab for: a drone, a boat and a planner
Study and examination requirements and forms of examination	Written Mid-Term Exam (25%) + Oral Presentation of Project (25%)+Written Final Exam (50%)
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Workshop Handbook in Lab Video projection
Reading list	-ROBOTICS VISION AND CONTROL FUNDAMENTALS - PETER CORKE - THEORY OF APPLIED ROBOTICS KINEMATICS DYNAMICS AND CONTROL – REZA N. JAZAR -ROBOT MODELLING AND CONTROL -MARK SPONG - Kuka KR6 R700 robots Guidebook

U4.3: Mechatronics Elmements 4

U4.3.2 Real Time Programming

Module designation	Mechatronics Elements 4
Module level, if applicable	2nd year Semester 2
Code, if applicable	U4.3
Subtitle, if applicable	
Courses, if applicable	Real Time Programming
Semester (s) in which the module is taught	Semester 4
Person responsible for the module	Dept. Head Emna Rabhi
Lecturer	Faten SALEM
Language	French
Relation to curriculum	Professional module
Type of teaching, contact hours	21 hours Workshop 21 hours Projects
Workload	Total 84 hours/semester (42 hours of self-study/semester)
Credit points	3
Requirements according to the examination regulations	Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	C language, Microcontrollers Architectures
Module objectives/intended learning outcomes	**Objectives:** Embedded OS, particularly embedded Linux systems, are used today in a lot of industrial applications because of their stability. Let us quote by way of example: Android, eCos, FreeRTOS ... are currently worn on most Smart Phones, communicating kits and development boards. **Learning Outcomes:** Students will be able to : 1.Implement any application using FreeRTOS 2. Mastery of the queue and semaphore mechanism

Content	**Classroom Lecture** **Chapter 1.** OS and real-time concepts **Chapter 2.** Creation of Tasks **Chapter 3.** Scheduling of Tasks **Chapter** 4. Communication between Tasks-Queue **Chapter** 5. Synchronization between semaphore tasks and Mutex **Chapter** 6. Interruption management **Practical Workshop** Lab: Practice of FreeRTOS by CMCIS-OS on a Cortex-M • FreeRTOS APIs • CMCIS-OS APIs • Applications
Study and examination requirements and forms of examination	Workshop Continuous assessment (20%) + Project (oral presentation) (80%)
Media employed	STM32F4 Discovery cards + PC Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Video projection
Reading list	1. Richard Barry "Using the FreeRTOS Real Time Kernal- A practical Guide" FreeRTOS homepage [online: www.FreeRTOS.org] 2. Doug Abbott "Linux for Embedded and Real-time Application" Elsevier science 2003- ISBN: 0-7506-7546-2

List of Electives:

Elective Unit 1: **IOT Advanced**	Elective Module 1 **: IOT Networks**
	Elective module 2 **: Embedded Linux**
Elective Unit 2: **Automotive embedded system**	Elective module 1 **: Automotive communication protocol ENG**
	Elective module **2 : Embedded Linux**

U4.4 Elective Unit 1: IOT Advanced

U4.4.1 Elective Module 1: IOT Networks

Module designation	**Elective Unit 1 : IOT Advanced**
Module level, if applicable	2nd year of Mechatronics engineering
Code, if applicable	U4.4
Subtitle, if applicable	-
Courses, if applicable	**IOT Networks**
Semester (s) in which the module is taught	-Semester 4
Person responsible for the module	Dept. Head Dr Emna Rabhi
Lecturer	M Ahmed Boughanmi
Language	French
Relation to curriculum	Elective Professional module
Type of teaching, contact hours	21 hours Workshop in Lab 21 hours Projects
Workload	Total 84 Hours (42 Hours of Self Study)
Credit points	3
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Non
Module objectives/intended learning outcomes	**Objectives:** give the essential notions for a good understanding of networks **Learning Outcomes:** The student will be able: - explain what a network is, what it is made up of - Write the network equipment and its mode of operation.

Content	**workshop** Chapter 1: Layered models: OSI & TCP/IP Chapter 2: Internet Layer (IP, ICMP, ARP/RARP) Chapter 3: Transport layer (TCP, UDP) Chapter 4: Application layer (HTTP, DNS, SMTP, FTP...) Network Programming **Practical Project** Installation and configuration of a Web server – Apache IP addressing and routing Programming by sockets – MiniTchat
Study and examination requirements and forms of examination	Workshop Continuous assessment (20%) + Project(oral presentation) (80%)
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT)
Reading list	-Réseaux de Andrew Tanenbaum - Les Réseaux (edition2005) de Guy Pujolle -TCP/IP : Architecture protocoles et applications de Douglas Comer

U4.4 Electives Unit 1 : IOT Advanced

U4.4.2 Elective module 2 Embedded Linux

Module designation	**Elective Unit 1: IOT Advanced**
Module level, if applicable	2nd year of engineering Cycle
Code, if applicable	U4.4
Subtitle, if applicable	-
Courses, if applicable	Elective module 2 : Embedded Linux
Semester (s) in which the module is taught	Semester 4
Person responsible for the module	Dept. Head Emna Rabhi
Lecturer	Mme Faten Salem
Language	**English**
Relation to curriculum	Professional Module, Electives
Type of teaching, contact hours	21 hours Workshop 21 hours Projects
Workload	Total 84 Hours (42 Hours of Self Study)
Credit points	3
Requirements according to the examination regulations	-Minimum Attendance rate : 80% >20% of non-attendance= elimination for exams
Recommended prerequisites	Microcontrollers Architecture
Module objectives/intended learning outcomes	**Objectives:** 1. Understand the fundamental structure of Embedded Linux 2. Become proficient in the different device driver frameworks of Linux Kernel. 3. Understand Infrastructure provisions that serve as building blocks of the driver frameworks. 4. To enable participants interested in Android platform porting for custom hardware **Learning Outcomes:** At the end of the course, the student have the ability to: 1. Build embedded applications using boards 2. Manipulate the Linux sub system infrastructure that supports a program execution 3. Understand the management of CPU resource in Linux 4. Use the management of File System and File resources 5. Use the diagnostic aids in Linux and driver debugging

Content	**Contents** 1. What is an OS operating system 2. Linux for the embedded systems 3. Handling of Linux for the embedded systems 4. Concept of boot loader 5. Cross-compilation 6. Familiarization with debugging process 7. Configuration and compilation of the Linux Kernel 8. Real time system 9. Real-time embedded systems 10. Scheduling of tasks **Practical Project** Practical work on Raspberry Pi prototyping boards
Study and examination requirements and forms of examination	Continuous assessment (20%) + Project(oral presentation) (80%)
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Video projection
Reading list	1- LIVRE DE LINUX EMBARQUEE : Pierre Ficheux Préface de Marc Palazon

U4.4 Elective Unit2 : Automotive Embedded System

U4.4.1 Elective Module 1: Automotive Communication Protocols

Module designation	Automotive Embedded System
Module level, if applicable	2nd year of engineering Cycle
Code, if applicable	U4.4
Subtitle, if applicable	-
Courses, if applicable	Automotive Communication Protocols
Semester (s) in which the module is taught	Semester 4
Person responsible for the module	Dept. Head Emna Rabhi
Lecturer	Dr Lahbib Younes
Language	**English**
Relation to curriculum	Professional Module, Electives
Type of teaching, contact hours	21 Workshop 21 Projects
Workload	Total 77 Hours (35 Hours of Self Study)
Credit points	3
Requirements according to the examination regulations	-Minimum Attendance rate : 80% >20% of non-attendance= elimination for exams
Recommended prerequisites	Microcontrollers Architecture
Module objectives/intended learning outcomes	**Objectives:** This course provides a thorough and comprehensive introduction to : Automotive multiplexed network buses, covering the technical principles, Architectures for vehicular communication systems, 5. smart and connected vehicle **Learning Outcomes:** At the end of the course, the student have the ability to 1. Establish the need of Networking in an Automobile 2. Explain and analyse the principles and functionalities of various Automotive Communication Protocols (ACPs) 3. Design, simulate, emulate and analyse CAN and LIN based automotive embedded networks 4. Design ACP based In-Vehicle Networks (IVNs) 5. Proficiently use Vector CANoe tool to develop IVN applications as well as to simulate, analyze and Troubleshoot ACP based IVNs

Content	**Contents** 1. The Controller Area Network (CAN) protocol, 1.1 Physical layers, 1.2 Conformity problems, 1.3 Hardware and software tools, 1.4 Application layers. 2. New local interconnect network (LIN) bus, 3. Time-triggered CAN (TTCAN), 4. FlexRay 5. X-by-Wire. 6. Fail-Safe-System basis chip (SBC) design 7. Analysis of wired and wireless internal and external serial links, 7.1 Safe-by-Wire plus, 7.2 I2C, 7.3 Media Oriented Systems Transport (MOST), 7.4 Remote keyless entry, tyre pressure monitoring systems (TPMS) 7.5 Bluetooth. **Workshop & Projects:** Workshop using Vector CANoe tool to simulate, analyse and Troubleshoot ACP based IVNs & develop IVN applications
Study and examination requirements and forms of examination	Evaluation of report, and oral presentation (100%)
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Video projection
Reading list	1-Vehicular Communications And Networks: Architectures, Protocols, Operation And Deployment Author: Wai Chen Publisher: Elsevier ISBN: 9781782422167 2- Society for Automotive Engineering www.sae.org

U4.4 Elective Unit 2: Automotive Embedded System

U4.4.2 Elective Module 2: Embedded Linux

Module designation	Automotive Embedded System
Module level, if applicable	2nd year of engineering Cycle
Code, if applicable	U4.4
Subtitle, if applicable	-
Courses, if applicable	Embedded Linux
Semester (s) in which the module is taught	Semester 4
Person responsible for the module	Dept. Head Emna Rabhi
Lecturer	Mme Faten Salem
Language	**English**
Relation to curriculum	Professional Module, Electives
Type of teaching, contact hours	21 hours Workshop 21 hours Projects
Workload	Total 77 Hours (35 Hours of Self Study)
Credit points	3
Requirements according to the examination regulations	-Minimum Attendance rate : 80% >20% of non-attendance= elimination for exams
Recommended prerequisites	Microcontrollers Architecture
Module objectives/intended learning outcomes	**Objectives:** 5. Understand the fundamental structure of Embedded Linux 6. Become proficient in the different device driver frameworks of Linux Kernel. 7. Understand Infrastructure provisions that serve as building blocks of the driver frameworks. 8. To enable participants interested in Android platform porting for custom hardware **Learning Outcomes:** At the end of the course, the student have the ability to: 6. Build embedded applications using boards 7. Manipulate the Linux sub system infrastructure that supports a program execution 8. Understand the management of CPU resource in Linux 9. Use the management of File System and File resources 10. Use the diagnostic aids in Linux and driver debugging

Content	**Contents** 1. What is an OS operating system 2. Linux for the embedded systems 3. Handling of Linux for the embedded systems 4. Concept of boot loader 5. Cross-compilation 6. Familiarization with debugging process 7. Configuration and compilation of the Linux Kernel 8. Real time system 9. Real-time embedded systems 10. Scheduling of tasks **Practical Project** Practical work on Raspberry Pi / STM32 prototyping boards
Study and examination requirements and forms of examination	Continuous assessment (20%) + Project(oral presentation) (80%)
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Video projection
Reading list	1- LIVRE DE LINUX EMBARQUEE : Pierre Ficheux Préface de Marc Palazon

U4.5 : Languages & Social Science 4

U4.5.1 : English TOEIC 2

Module designation	Languages & Social Science 4
Module level, if applicable	2nd year
Code, if applicable	U4.6
Subtitle, if applicable	
Courses, if applicable	English TOEIC 1
Semester (s) in which the module is taught	Semester 4 (S4)
Person responsible for the module	Dr Emna Rabhi
Lecturer	Mme Hajer MAMI + Mme Amal ZWAGA
Language	**English**
Relation to curriculum	Integrated course module
Type of teaching, contact hours	Lecture, 42 hours of classroom course/ semester
Workload	Total 63 hours/semester (21 hours of Self-Study/semester)
Credit points	2.5 credits
Requirements according to the examination regulations	Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	General English S1 & S2
Module objectives/intended learning outcomes	**Objectives:** Prepare students to take TOEIC test by providing related necessary linguistic knowledge. Focus is put on how to approach the different parts of test items and to develop test taking skills, in order to reach the highest score possible. **Learning Outcomes:** By the end of the course the student should be able to: General Competencies - Reach the highest score possible - Develop at most his/her Listening and reading skills. Specific Competencies - Recognize the different parts of TOEIC. - Develop tactics and strategies appropriate to each type of activity, (ex: skimming and scanning). - Distinguish tasks to be performed in every activity. - Establish a proper pace to follow throughout the exam. - Managing allocated time. - Follow steps

Content	**Part I : Listening** **Chapter 1. Photographs** Distractor 1 : Sound Confusion Distractor 2 : Verb/Noun Confusion Distractor 3 : Non-Itemed Pictures Distractor 4 : Action /State confusion **Mini Test** **Chapter 2. Question and Response** Distractor 1 : Repeating words Distractor 2 : Related words Distractor 3 : Wrong Subject Distractor 4 : Wrong TenseAnswering Wh-Questions with Yes or No Distractor 5 : Negative Questions Distractor 6 : Tag Questions **Mini Test** **Chapter 3. Conversations (two or more speakers)** Distractor 1 : Topic Questions Distractor 2 : Detail Questions Distractor 3 : Inference Questions Distractor 4 : Types of situations **Mini Test** **Chapter4. Talks (one single speaker)** Distractor 1 : Topic Questions Distractor 2 : Speaker/Audience Questions Distractor 3 : Detail Questions Distractor 4 : Types of Talks **Mini Test** **Part II. Reading** **Chapter 1. Incomplete Sentences** Vocabulary Based Items Grammar Based Items **Mini Test** **Chapter 2. Text Completion** Grammar Concepts **Mini Test** **Chapter 3. Reading Comprehension** Question Types Passage Types Multiple passage Items **Mini Test**

Study and examination requirements and forms of examination	Continuous assessment through mini test A common test for all types of Engineering by the end of each semester Listening Exam (Semester I): 100 questions /multiple choice: 45minutes. Listening and Reading Exam (Semester II): 200 questions/ multiple-choice 120 minutes.
Media employed	Textbook/ hard copies for Classroom
Reading list	1. Dooley, J. (2019). Prepare and Practice for the TOEIC Test. Express Publishing. 2. G rant, T. (2007). Tactics for Toeic. Oxford University Press

U4.5 : Languages & Social Science 4

U4.5.2 : Lean Management

Module designation	Languages & Social Science 4
Module level, if applicable	Year 2, Semester 2
Code, if applicable	U4.5
Subtitle, if applicable	
Courses, if applicable	**Lean Management**
Semester(s) in which the module is taught	Semester 4
Person responsible for the module	Dr Emna RABHI
Lecturer	Dr. Frah Chenchah
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	Lecture, 21 hours Classroom Lecture/ Semester
Workload	Total 42hours/ Semester (21 hours of Self Study)
Credit points	1.5
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Production Management
Module objectives/intended learning outcomes	**Objectives:** 1- Understand the Lean Management spirit 2- Master the different tools of lean management 3- Synchronize flows, 4- Reduce manufacturing times and increase production flexibility

Content	**Chapter I: Lean Thinking** a. Lean Management Concept b. Lean manufacturing and Lean Management differences c. Lean and continuous improvement initiatives. d. The principle of added value for the customer. e. The notion of "waste". f. The process model. **Chapter II: How to deploy the Lean management approach** a. The deployment plan. b. Performance indicators. c. Training. d. The conduct of the group at work. **Chapter III: Lean Manufacturing Concept** a. Introduction b. Origins and history of lean c. Concepts and tools d. 5S and Visual Management e. Autonomous Production Unit f. Jidoka g. Kaizen and PDCA h. PokaYoke (Anti-Errors Systems) i. Quick Tool Change (SMED) j. Pulled stream (just in time) k. Standardized work l. Total Productive Maintenance (TPM) m. Value stream n. 6 sigma **Chapter IV: 5S Method** a. Origin of 5S b. Procedure for carrying out a 5S project c. Definition of 5S d. The stages of 5S e. Examples of application f. 5S projects **Chapter V: Location of factories** a. Production typology b. The different production organizations c. Design of a modern production unit d. Analysis methods **Chapter VI: Value Stream Mapping** a. Principles of VSM b. The stages of the current state c. Current state drawing in the field d. Complete data box and information flow e. Identification of areas for improvement f. Calculation of flow time and VA time
Study and examination requirements and forms of examination	Written Mid-Term Exam (40%) + Written Final Exam (60%)

Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Video projection
Reading list	LEAN MANAGEMENT: OUTILS, METHODES, RETOURS D'EXPERIENCES, QUESTIONS/, CHRISTIAN HOFFMAN, 2012 SYSTEME LEAN: PENSER L'ENTREPRISE AU PLUS JUSTE, JAMES P. WOMACK, DANIEL T. JONES, LES BASIQUES DU LEAN MANUFACTURING: DANS LES PMI ET ATELIERS TECHNOLOGIQUES, PIERRE BEDRY, 2009

U4.6: Annual Project

U4.6.1: Annual Project 2

Module designation	**Annual Project**
Module level, if applicable	Year 2, Semester 2
Code, if applicable	U4.7
Subtitle, if applicable	
Courses, if applicable	**Annual Project 2**
Semester(s) in which the module is taught	Semester 2 (S4)
Person responsible for the module	Dr Emna RABHI
Lecturer	M Nizar Merteh
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	21 hours for project supervision/ semester
Workload	Total 51 hours/ Semester (30 hours of Self Study)
Credit points	2
Requirements according to the examination regulations	- Minimum attendance rate: 80% of the total contact hours >20 % of nonattendance = elimination for exams
Recommended prerequisites	Tools: Matlab, Labview, Eagle, Isis-Ares… Microcontrollers and PIC: Arduino, STM32, Rasberry pi Embedded system design and realisation : for different applications
Module objectives/intended learning outcomes	This is an exercise that will help student to apply knowledge's & Skills to work and present a basic project. **Objectives :** ✓ Sizing and choice of solution ✓ Project studies: functional and structural analysis, design (preparation of technical files) ✓ Design Simulation using appropriate software & tools

Content	**Project 1: Power measurement module with alert** -Arduino programming - Propose an optimal solution - Electronic power calculation **Project 2: Secure Access Control** -Arduino programming - Fingerprint, RFID and code - Case design + Realization **Project 3: Input Raspberry Pi with LeapMotion** -Raspberry Pi Programming - Mouse Input API - Change of mark **Project 4: Interactive Mirror:** - Design (Solidworks or Catia) + Realization - Raspberry Pi programming – Python app **Project 5: IOT module for remote lighting control (Local)** - Arduino Node MCU programming - Design of electronic card (according to specifications) + Realization - Android App (Optional)
Study and examination requirements and forms of examination	100% Oral Exam (Project presentation + report+ Poster session)
Media employed	Video Projection
Reading list	REFERENCES ARE GIVEN BY SUPERVISORS