ULT Mechatronics Engineering

Subjects Modules for S5

Semester 1 Year 3

U5.1: Electronics Electrotechnics 5 EE 5

U5.1.1: Analysis & Control of Complex Systems

Module designation	Electronics Electrotechnics 5 EE 5
Module level, if applicable	**Year 3, Semester 1**
Code, if applicable	U5.1
Subtitle, if applicable	
Courses, if applicable	Analysis & Control of Complex Systems
Semester(s) in which the module is taught	Semester 5
Person responsible for the module	Dr Emna RABHI
Lecturer	Dr Emna RABHI
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	Lecture, 21 hours Classroom Lecture/ Semester
Workload	Total 51hours/ 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	Calculus, Math for Engineering 1 & 2, Linear Systems Analysis, Automatic Control
Module objectives/intended learning outcomes	**Objectives:** At the end of this course, the student will be able to: 1- Present the foundations of the analysis and synthesis of the control law for nonlinear systems. 2- Determine the amplitude and frequency of limit cycles by the first harmonic method. 3- Determine the stability, in the sense of Lyapunov, for the points of equilibrium, and the associated theorems, property of passivity and its consequences allowing to guarantee the stability of a linear system comprising a non-linearity of the static type.

Content	**Chapter 1: NON-LINEAR CONTINUOUS CONTROLS ANALYSIS** 1- General Introduction 2- Different types of non-linearity 3- Study of the linearity domain of a system 4- The phenomenon of saturation 5- Determination of the linearity domain of a controlled system 6- Characteristics of some nonlinear organs 7- All-or-nothing and Hysteresis systems 8- Complex features 9- Separable non-linear drives **Chapter 2: Separable System Study using the first harmonic method** 1- Principle 2- Equivalent complex gain 3- Concept of critical place 4- Example 5- First harmonic method 6- Method of approximate calculation of the equivalent complex gain **Chapter 3: Nonlinear Systems Stability** 1- Generalized transfer function 2- Principle of the study 3- Example **Chapter 4: Cypkin's Locus Study Method** 1- Principle 2- Example **Chapter 5: Phase plan method** 1- Principle 2- Tracing the trajectories 3- Analysis of trajectories and system diagnosis
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- Philippe Müllhaupt Introduction à l'analyse et à la commande des systèmes non linéaires 2- D Normand-Cyrot, Collectif, A Fossard, SYSTEMES NON LINEAIRES. Tome 3, Commande 3- HANUS Raymond, Automatique avancée 2 : commande des systèmes non linéaires.

U5.1: Electronics Electrotechnics 5 EE 5

U5.1.2: industrial Programmable Automated

Module designation	**Electronics Electrotechnics 5: EE5**
Module level, if applicable	Year 3, Semester 1
Code, if applicable	U5.1
Subtitle, if applicable	
Courses, if applicable	**Industrial Programmable Automated API**
Semester(s) in which the module is taught	Semester 5
Person responsible for the module	Dr Emna RABHI
Lecturer	Dr. Mohamed Aymen Slim
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	Lecture, 21 hours Classroom Lecture/ Semester 42 hours for Workshop in Lab / semester
Workload	Total 84 hours/ Semester (21 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	Logic functions ; Sensors-Actuators; Industrial Control 1
Module objectives/intended learning outcomes	**Objectives:** 1. Understand Structured Programming using GRAFCET (GEMMA Interface) 2. Learn and practices structured programming on Siemens PLC - S7-1200 PLC under TIAPortal 3. Understand the utility of the programming of Analog I / O and other resources on the PLC 4. Understand the PLC Supervision (SCADA) in real application

Content	**Lecture & Lab Workshop** **Part 1: Industrial Programmable Logic Controller (PLC)** 1- Structure of an automated production system 2- Sensors-Actuators 3-External API architecture 4- Internal architecture and concept of PLC scanning **Part 2: Programming of PLC** 1- Basic concept of PLC programming 2- Introduction to PLC programming language (Ladder diagram) 3- Time delay block- Counter block 4- Application exercises **Part 3: Functional Graphic of Steps / Transitions Control GRAFCET (or SFC)** 1- Basic concept of GRAFCET (or SFC) 2- OR and AND referrals for GRAFCET 3- Logical equation of a step 4- Macro step and encapsulation 5- Application exercises (GRAFCET -PLC programming) **Part 4: GRAFCET and GEMMA** 1- Description of GEMMA Environment 2- Structured programming using **GRAFCET** 3-Practical application Siemens PLC S7-1200 **Part 5: Structured programming of PLC** 1- Basic concept of structured PLC programming 2- OB, FB, FC, DB Blocks - PLC S7-1200 3- Practical application on Siemens PLC S7-1200 PLC **Part 6: PLC Analog Inputs / Outputs** 1- Description of PLC Analog I / O 2- Practical application Analog I / O - S7-1200 3- Practical application: Clock Memory bits, fast count inputs **Part 7: PLC Supervision (SCADA)** 1- Basic concept on the supervision of industrial processes 2- Human Machine Interface (HMI) for PLC supervision 3- Practical applications- HMI (supervision) PLC S7-1200- WINCC Interface ****Abbreviations in French & English are presented to Students:*** **1. GRAFCET**: GRAphe Fonctionnel de Commande Etapes Transitions ***Equivalent: *SFC :*** *Sequential Function Chart* **2. API:** Asservissement des Processus Industriel ***Equivalent : PLC****: Programmable Logic Controller for Industry* **3. GEMMA:** Guide d'Etude des Modes de Marche et d'Arrêt It is Graphic Interface

	4. SCADA: *Supervisory Control And Data Acquisition* ***5. HMI :*** *Human Machine Interface* *****GRAFCET & GEMMA Tools Developed by ADEPA France :*** *National Agency for the Development of Productics Applied to Industry*
Study and examination requirements and forms of examination	Written Mid-Term Exam (25%) + Practical Workshop and project Oral presentation(25%)+Written Final Exam (50%)
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Workshop handbook + Siemens S7-1200 PLC Video projection
Reading list	- AUTOMATES PROGRAMMABLES INDUSTRIELS ; WILLIAM BOLTON ; EDITION DUNOD (2015) - LE GRAFCET ; SIMON MORENO, EDMOND PEULOT ; EDITION EDUCALIVRE (2003)

U5.2: Mechanics 5

U5.2.1: Finite Element Method & Abaqus

Module designation	**Mechanics 5**
Module level, if applicable	**Year 3, Semester 1**
Code, if applicable	U5.2
Subtitle, if applicable	
Courses, if applicable	Finite Element Method & Abaqus
Semester(s) in which the module is taught	Semester 5
Person responsible for the module	Dr Emna RABHI
Lecturer	Dr. Amine KAROUI
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	Math (Matrix), Continuum Mechanics, Linear systems
Module objectives/intended learning outcomes	**Objectives:** 1. Introduction to the Finite Element Method FEM 2. Understand application of FEM through some applications 3. Learn using ABAQUS tools for simulation an of some structure application and result analysis .

Content	**Chapter I. Introduction to the Finite Element Method FEM** 1. Presentation of numerical calculation methods 2. Presentation of the Elements Method Concept in implicit calculation 2.1. Description of discretization (mesh) 2.2. Degree of Freedom Description (nodal values unknowns) 2.3. Interpolation Matrices Definition 2.4. Construction of the elementary stiffness matrixes 2.5. Assembly principle of elementary stiffness matrices in order to arrive at the global matrix 2.6. Notions of boundary conditions and their consideration in calculations. 2.7. Expression of the global force vector and its assembly. 2.8. Expression of the linear system to be solved. **Chapter II. Application of the Finite Element Method to traction-compression problem** 1. Developments and determination of interpolation functions 2. Expression of the elementary stiffness matrix from mechanical computation 3. Construction of the total matrix of rigidity (assembly) 4. Principle of discretization of distributed loadings. 5. Expression of the global force vector and its assembly. 6. Resolution of the linear problem after reduction by the boundary conditions. **Chapter III. Application of FEM to the resolution of plane bending beam problems.** 1. Developments and determination of interpolation functions 2. Expression of the elementary stiffness matrix from the potential energy of elastic strain 3. Construction of the total matrix of rigidity (assembly) 4. Principle of discretization of distributed loadings. 5. Expression of the global force vector and its assembly. 6. Resolution of the linear problem after reduction by the boundary conditions. **Chapter IV. Application of FEM to solving thermal problems (through a composite wall)** 1. Expressions of the different forms of heat exchange, thermal equilibrium equation 2. Development of the variational formulation (transition from the strong formulation to the weak formulation). 3. Developments and determination of interpolation functions. 4. Expression of the elementary stiffness matrix starting from the variational formulation. 5. Construction of the total matrix of rigidity (assembly). 6. Expression of the various thermal force vectors and assembly of the global vector. 7. Resolution of the linear problem after reduction by the boundary conditions.

	Practical workshop in Laboratory **TP 1:** Getting started - Philosophy of finite element calculation codes - Modelling approach of a physical problem on ABAQUS - Introduction to ABAQUS CAE, features, menus, modules, etc. **TP2:** Study of a lattice structure - Geometry drawing on Abaqus - Introduction of the various calculation parameters - Taking into account the boundary conditions - Meshing and problem solving - Results analysis **TP3:** Study of a tensile test specimen - 2D modelling of the test specimen on Abaqus - Problem setting - Division of the test specimen into several subdomains in order to make several meshes - Solving the problem and generating specific results **TP4:** Study of deformations in a 3D part - 3D modelling of the part on ABAQUS - Problem setting - Mesh and resolution - Results analysis **TP5:** Study of the linear impact on a plate - Modelling of the plate and the cylinder impact - Modelling of the problem (interaction between parts) - Mesh and resolution - Study of the results
Study and examination requirements and forms of examination	Written Mid-Term Exam (25%) + Practical Workshop Exam(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	-An introduction to the finite element method (3rd edition), by J N REDDY -Méthode des éléments finis : flexion des poutres a plan moyen, YVES DEBARD (cours) -Méthode des éléments finis en thermique et en thermomécanique, L. CHAMPANEY (cours) -Les éléments finis : de la théorie à la pratique, André Fortin Université Laval et André Garon École Polytechnique de Montréal. (Cours) -Dassault Systems Abaqus CAE website: 3ds.com

U5.2: Mechanics 5

U5.2.2: Advanced Robotics

Module designation	**Mechanics 5**
Module level, if applicable	**Year 3, Semester 1**
Code, if applicable	U5.2
Subtitle, if applicable	
Courses, if applicable	Advanced Robotics
Semester(s) in which the module is taught	Semester 5
Person responsible for the module	Dr Emna RABHI
Lecturer	Dr. Amjed MOUELHI
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	Workshop 21 hours in Lab/ 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	Robotics 1 & 2, Robot Programming, Automatic Control, Solid Mechanics, Math
Module objectives/intended learning outcomes	**Objectives:** 1. This last Workshop will enable students to practice easily the Robot Manipulator 2. Learn to solve movement planning problems of the robot 3. Command the Robot Manipulator to perform a specific task through various examples during the Workshop

Content	**Chapter 1- Introduction to nonlinear control of manipulator** **1.** Introduction 2. The Control Problem For Manipulators 3. Properties of the Dynamic Model 4. Lyapunov stability analysis **Chapter 2 Position control of manipulator** 1. Introduction 2. Proportional Control plus Velocity Feedback and PD Control 3. PD Control with Gravity Compensation **Chapitre 3 : Robot control by Pre-computed Torque-I** **Chapitre 4: Robot control by Pre-computed Torque -II** **Chapitre 5: Force control of Robot Manipulator** **Chapitre 6: Robot Manipulator Control by sliding modes**
Study and examination requirements and forms of examination	Continuous Assessment 40% (Report for each workshop required) +Semester Workshop Exam 60 %
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Video projection
Reading list	- Robot modelling and control : M.W.Spong - Introduction to Robotics: Mechanics and Control (3rd Edition) 3rd Edition John J. Craig

U5.3: Mechatronic Elements 5

U5.3.1: Reliability & Safety of Mechatronics systems

Module designation	**Mechatronic Elements 5**
Module level, if applicable	**Year 3, Semester 1**
Code, if applicable	U5.3
Subtitle, if applicable	
Courses, if applicable	Reliability & Safety of Mechatronics systems
Semester(s) in which the module is taught	Semester 5
Person responsible for the module	Dr Emna RABHI
Lecturer	Dr. RAOUADI Mohamed Haithem
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	Lecture, 21 hours Classroom Lecture/ Semester
Workload	Total 42hours/ 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	Electrical
Module objectives/intended learning outcomes	**Objectives:** 1. Characterize the concepts of the dependability of a system. 2. Identify the methods and tools applicable to the analysis of the dependability of a system. 3. Apply Reliability calculation and control techniques when designing a system.

Content	**Chapter 1. Reliability and Company Global Optimization** 1. Introduction 2. General and definitions 3. Reliability and reliability typology 4. Reliability models and laws **Chapter 2. Reliability Estimation Using Probability Theory** 1. Scenario 2. The exponential law 3. The normal law 4. Weibull's law 5. Estimation by observation 6. Graphic adjustment of the Weibull law 7. Reliability Improvement Methods **Chapter 3. Markov chain** 1. Discrete time Markov chain 2. Continuous-time Markov chain **Chapter 4. Maintainability indicators** **Chapter 5. Cost of non-availability**
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. VILLEMEUR Sûreté de Fonctionnement de Systèmes Industriels, Editions Eyrolles 2. G. ZWINGELSTEIN Diagnostic des Défaillances : Théorie et Pratique pour les Systèmes Industriels, Editions Hermes 3. JC FRANCASTEL le fond de la baignoire : chez Dunod 4. I. BAZOVSKY Théorie et Pratique de la Sûreté de Fonctionnement, Editions Dunod 5. M. CORAZZA Techniques Mathématiques de la Fiabilité Prévisionnelle Cepadues-Editions 6. F. MONCHY, Maintenance méthodes et organisations, Dunod, 2003 Management de la Maintenance 2e édition, Editeur : Dunod ; 2008 2e édition

U5.3: Mechatronic Elements 5

U5.3.2: Computerized Maintenance Management System CMMS

Module designation	Mechatronic Elements 5
Module level, if applicable	Year 3, Semester 1
Code, if applicable	U5.3
Subtitle, if applicable	
Courses, if applicable	Computerized Maintenance Management System CMMS
Semester(s) in which the module is taught	Semester 5
Person responsible for the module	Dr Emna RABHI
Lecturer	Dr. Riheb Mechmech
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	21 hours for Workshop in Lab/ semester 21 hours for Prjects
Workload	Total 84hours/ 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	Industrial maintenance
Module objectives/intended learning outcomes	**Objectives:** 1. Understand the different basic aspects of industrial maintenance (preventive maintenance, corrective maintenance, reliability, etc.) 2. Understand CMMS Computerized Maintenance Management System 3. Practices in Lab using OptiMaint tools to go through all aspect of the management system using the three workshop sessions

Content	**Course highlights:** • Preventive maintenance. • Corrective maintenance. • Reliability of systems. • Failure Mode Effects and Criticality Analysis • Total productive maintenance. **Workshops (in Lab):** **TP1:** EQUIPMENT AND PERSONNEL MANAGEMENT 1- Creation of equipment. 2- Creation of organs. 3- Creation of stakeholders. 4- Creation of articles. **TP2:** STOCKS AND PURCHASES MANAGEMENT: 1- Creation of suppliers. 2- Stock Inventory management. 3- Purchasing management. **TP3:** INTERVENTIONS MANAGEMENT 1- Corrective interventions. 2- Preventive interventions. **Projects topics:** • TPM (total productive maintenance). • FMECA study. • Maintenance dashboard. • Development of a CMMS
Study and examination requirements and forms of examination	100% practical evaluation (Workshop) +Project evaluation (Presentation+ Report)
Media employed	Workshop Handbook in Lab Video projection
Reading list	OPTIMAINT Software User Guideline

U5.4: Computer Science

U5.4.1: Artificial Intelligence (AI)

Module designation	**Computer Science**
Module level, if applicable	**Year 3, Semester 1**
Code, if applicable	U5.4
Subtitle, if applicable	
Courses, if applicable	Artificial Intelligence (AI)
Semester(s) in which the module is taught	Semester 5
Person responsible for the module	Dr Emna RABHI
Lecturer	Dr Farah CHENCHAH
Language	**English**
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	Lecture, 21 hours Classroom Lecture/ Semester
Workload	Total 51hours/ 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	Algorithmic, Object Oriented Programming, Python, Linear Algebra
Module objectives/intended learning outcomes	**Objectives:** 1. Know the foundations of artificial intelligence 2. Understand the characteristics and basic techniques used for artificial intelligence. 3. Master the AI development history, the Huawei Ascend AI system, the full-stack all-scenario AI strategy and algorithms related to traditional machine learning and deep learning. Learning Outcomes **Learning Outcomes:** Students will be able to : 1. Build, train, and deploy neural networks by using development frameworks TensorFlow and MindSpore. 2.Be a developer, product manager, technical support, and other AI positions. 3.Obtain the HCIA-AI (H13-311) certification

Content	**Chapter 1. Introduction to Artificial Intelligence AI** 1.1. History 1.2. Definition 1.3. Future of Artificial Intelligence **Chapter 2. Python** 2.1. What is Python 2.2. Basic types 2.3. Conditional and iterative structures 2.4. Functions 2.5. Regular expressions 2.6. File manipulation **Chapter 3. The Basics of Mathematics** 3.1. Linear algebra 3.2. Probability theory 3.3. Information theory 3.4. Numerical calculation **Chapter 4. Machine Learning and deep learning** 4.1. Machine Learning 4.2. Deep Learning **Chapter 5. Development Framework and Platform For IA** 5.1. Tensor Flow 5.2. Huawei AI: MindSpore 5.3. Huawei AI : Atlas 5.4. Huawei AI : HiAI 5.5. HUAWEI CLOUD EI **Chapter 6. Comprehensive AI Experiment** 6.1. Machine Learning Experiment 6.2. Mainstream Development Framework and Deep Learning Experiment
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. S. Russell And P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, 2002 2. J-G. Ganascia, L'intelligence Artificielle. Flammarion, 1993 3. I. Bratko, Programmation En Prolog Pour L'intelligence Artificielle, 2001 4. J. Alliot Et T. Schiex, Intelligence Artificielle Et Informatique Theorique, Cepadues Editions, 1993 5. HCIA-AI Course (Huawei ICT Academy online)

U5.4: Computer Science

U5.4.2 Data Analysis

Module designation	Computer Science
Module level, if applicable	3nd year, Semester 1
Code, if applicable	U5.4
Subtitle, if applicable	-
Courses, if applicable	Data Analysis
Semester (s) in which the module is taught	-Semester 5
Person responsible for the module	Dept. Head Dr Emna Rabhi
Lecturer	Dr. Marwa HASNI
Language	French
Relation to curriculum	Professional module (compulsory)
Type of teaching, contact hours	21 hours Lecture 21 Workshop
Workload	Total 51 Hours (9 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	Programming
Module objectives/intended learning outcomes	**Objectives:** Familiarize students with data modelling and analysis using specific methods **Learning Outcomes:** Students will be able to : 1.Model an industrial problem using multiple regression tools 2.Master key tests to assess the robustness of the proposed models (confidence interval, correlation between variables) 3.Study and apply CP, AHP and Electre multi-criteria analysis methods to address decision support issues. 4.Provide an interpretation based on the models developed to assist in decision-making on the alternative solution(s) to the problem being studied 5.Master the use of Microsoft Excel and Python for regression data analysis 6.Master mass data analysis methods: ACP and AFC using SPSS and python

Content	**Chapter 1: Introduction to Data Analysis** 1/ Reminder on key concepts of descriptive database statistics 2/ Modelling an industrial problem by simple linear regression **Chapter 2: Multiple linear regression** 1/ Modelling (matrix calculation to estimate parameters) 2/ Application on Excel and python 3/Assessment of the robustness of regression models (development of tolerance intervals, correlation study) **Chapter 3: Introduction to Multi-criteria Analysis** 1/ The AHP method 2/ The Electre method 3/The Compromise programming (CP) method 3/Applications **Chapter 4: Principle Component Analysis** 1/ Concept and implementation steps 2/ Implementation on python, SPSS + Interpretation **Chapter 5: Correspondence Factor Analysis** 1/ Concept and implementation steps 2/ Implementation on python + Interpretation **Chapter 6 : Methods of classification** 1/ Hierarchical classification (Concept and implementation steps) 2/ Non-hierarchical classification (Concept and implementation steps) 3/ Implementation on python + Interpretation
Study and examination requirements and forms of examination	Written Mid-term Exam (25%) + Workshop(oral presentation) (25%)+Written Final Exam (50%)
Media employed	Course Material (Hard/ Soft copy) for Classroom + activity booklet Video projection
Reading list	Ref.1 : Benzécri, J.-P., & Coll., (1980). L'analyse des données, Tome 2 : l'analyse des correspondances, Dunod Ref 2 : Benzécri, J.-P., (1982). Histoire et préhistoire de l'analyse des données, Dunod Ref 3 : Benzécri, J.-P., Benzécri F., (1980). Pratique de l'analyse des données, Tome 1 : Analyse des correspondances. Exposé élémentaire, Dunod

U5.4 Computer Science

U5.4.3 Computer Vision

Module designation	**Computer Science**
Module level, if applicable	3rd year of mechatronic engineering
Code, if applicable	U5.4
Subtitle, if applicable	-
Courses, if applicable	**Computer vision**
Semester (s) in which the module is taught	Semester 5
Person responsible for the module	Dept. Head Dr Emna Rabhi
Lecturer	Dr Farah Chenchah
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	21 hours Workshop / projects
Workload	Total 51hours/ 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	1. Mathematics: Knowledge of and ability to use calculus, analytical geometry, linear algebra and probability theory. 2. Programming: Ability to program in Python. 3. Other Courses: There are no specific pre-requisite courses. In particular, courses in AI, Machine Learning, Deep Learning, Computer Vision and Image Processing are not required.
Module objectives/intended learning outcomes	This course provides an introduction to computer vision, including fundamentals of image formation, camera imaging geometry, feature detection and matching, stereo, motion estimation and tracking, image classification, scene understanding, and deep learning with neural networks. **Objectives :** Upon completion of this course, students will: • Be familiar with both the theoretical and practical aspects of computing with images; • Have described the foundation of image formation, measurement, and analysis; • Have implemented common methods for robust image matching and alignment; • Understand the geometric relationships between 2D images and the 3D world; • Have gained exposure to object and scene recognition and categorization from images; • Grasp the principles of state-of-the-art deep neural networks; and Developed the practical skills necessary to build computer vision applications.

Content	1. Introduction :Background, requirements and issues, human vision 2. Image formation: geometry and photometry Geometry, photometry (brightness and color), quantization, camera calibration 3. Image segmentation and Feature Extraction Various methods of image segmentation, edge detection, object proposals, SIFT features 4. Multi-view Geometry Shape from stereo and motion, feature matching, surface fitting, Active ranging 5. Object Recognition: Traditional Methods HoG/SIFT features, Bayes classifiers, SVM classifiers 6. Introduction to Neural Networks Artificial neural networks, loss functions, backpropagation and SGD, Batch Normalization 7. Object Recognition: Deep Learning Methods Image classification, object detection and semantic segmentation, adversarial attacks. Various neural network architectures, visualization techniques. 8. Motion analysis and Activity Recognition Motion detection and tracking, Inference of human activity from image sequences 9. Selected Topics Examples: Face recognition, Image grounding, Visual question answering
Study and examination requirements and forms of examination	Evaluation of report, and oral presentation (100%)
Media employed	Course Material (Hard/ Soft copy) for Classroom Video projection
Reading list	1. "Computer Vision: A Modern Approach", D. Forsyth and J. Ponce, 2010. 2. "Deep Learning: Algorithms and Applications", I. Goodfellow, Y. Bengio and A. Courville, 2017 (online version available at no cost for personal use). 3. "A Guide to Convolutional Neural Networks for Computer Vision", S. Khan, H. Rahmani, S.Shah and M. Bennamoun, 2018 (online version available from a USC account).

List of Electives:

Elective Unit 1: **Iot Advanced**	Elective Module 1 : **Cloud & Security**
	Elective module 2 : **IOT Chain Implementation**
Elective Unit 2: **Automotive embedded system**	Elective module 1 **Vehicle Embedded Systems ENG**
	Elective module 2 : **Vehicle Autonomous Systems ENG**

U5.5 Electives Unit 1: IOT ADAVANCED

U5.5.1 Cloud & Security

Module designation	**IOT Advanced**
Module level, if applicable	2nd year of Mechatronics engineering
Code, if applicable	U4.4
Subtitle, if applicable	-
Courses, if applicable	**Cloud & Security**
Semester (s) in which the module is taught	-Semester 5
Person responsible for the module	Dept. Head Dr Emna Rabhi
Lecturer	M Ahmed Boughanmi
Language	French
Relation to curriculum	Electives Professional module
Type of teaching, contact hours	21 course 21 Workshop / 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	
Module objectives/intended learning outcomes	**Objectives:** Introductory course in cloud computing addressing both the challenges and existing solutions on the market and also the practical aspects of cloud computing security, both in terms of identifying and assessing risks **Learning Outcomes:** students will be able to: - Understand the advantages and challenges of a total or part of a cloud computing strategy. - Understand how to introduce and manage a Cloud Computing project in a company -Ensure information security in cloud computing

Content	**CHAPTER 1 : What is Cloud Computing ?** - Definitions: type Technology Cycle - Cloud Computing Characteristics - Cloud Computing Service Models - Cloud Computing Deployment Models • **CHAPTER 2: Cloud Computing Framework** - Global Framework (public cloud, private cloud, hybrid cloud, …) - Cloud Computing Enablers - Cloud Computing Assets - Cloud Computing Challenges - Issues **CHAPTER 3 : Cloud Computing Security** - Fact & Figures - Security Advantages & Issues - Virtualization Risks **CHAPTER 4 : Cloud Computing Market Overview** **-** Main IaaS Offers - Main PaaS Offers - Main SaaS Offers § Other Offers **CHAPTER 5 : Cloud Computing Project Management** - Project Scenarios - Points of Attention - IT department roles **CHAPTER 6: Basic concept of information security** -Security of virtual environments -The security of network access to the Cloud -Cloud Computing Security according to ENISA - Control cloud security ***Practical Project are listed year by the Teacher.***
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)
-	- M. L. Badger, T. Grance, R. Patt-Corner, and J. M. Voas. (2012, May) Cloud Computing Synopsis and Recommendations. -P. Mell and T. Grance. (2009, July) The NIST Definition of Cloud Computing. White paper -R. Nyrén, A. Edmonds, A. Papaspyrou, and T. Metsch. (2011, April) Open cloud computing interface - core. White paper. Open Grid Forum -T. Metsch and A. Edmonds. (2011, June) Open cloud computing interface - infrastructure

U5.5 Electives Unit 1: IOT ADAVANCED

U5.5.2 IOT Chain Implementation

Module designation	**IOT Advanced**
Module level, if applicable	2nd year of Mechatronics engineering
Code, if applicable	U4.4
Subtitle, if applicable	
Courses, if applicable	**IOT Chain Implementation**
Semester (s) in which the module is taught	-Semester 5
Person responsible for the module	Dept. Head Dr Emna Rabhi
Lecturer	M Ahmed Boughanmi/M Moez Halaoui
Language	French
Relation to curriculum	Elective Professional module
Type of teaching, contact hours	42 Workshop / 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	Cloud et sécurité/ systeme embarqué/ linux embarqué
Module objectives/intended learning outcomes	**Objectives:** -the student must be able to implement an IOT chain by applying all his knowledge of embedded systems and IOT
Content	**Project axes:** The teacher proposes axes of implementation of an IOT chain and leaves the choice to the student - Smart city: smart road traffic, smart transport, waste collection, various maps (noise, energy, etc.). • Industrial control: measurement, prognosis and prediction of failures, remote troubleshooting. • Health: monitoring of biological parameters remotely. • Smart agriculture, home automation, playful 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)
Reading list	--

U5.5 ElectiveUnit 2 : Automotive Embedded System

U5.5.1 Elective Unit 1 Automotive Embedded System

Module designation	Automotive Embedded System
Module level, if applicable	3rd year of engineering Cycle
Code, if applicable	U5.5
Subtitle, if applicable	-
Courses, if applicable	Automotive Embedded System
Semester (s) in which the module is taught	Semester 5
Person responsible for the module	Dept. Head Emna Rabhi
Lecturer	Dr Lahbib Younes
Language	**English**
Relation to curriculum	Elective Professional Module
Type of teaching, contact hours	21 Workshop 21 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:** This course provides a comprehensive introduction to Automotive Embedded systems design, implementation and evaluation. **Learning Outcomes:** At the end of the course, student have the ability to: 1. critically evaluate different hardware implementation strategies and be able to assess their implications on both the functional and non-functional performance of the automotive embedded system 2. critically evaluate the different prototyping methods for design and verification of the automotive control system 3. propose a functional safety strategy for such system 4. Understand and apply principles of discrete control system's analysis and design.

Content	**Chapter 1. Introduction to Automotive Embedded Systems** • Introduction to Automotive Embedded Systems • Basic overview on different domains in Automotive Systems **Chapter 2. Introduction to Model based Development** • Overview of CAN & Flexray Protocol • Software Development demands in Automotive Industry • Introduction to Model based Development in MATLAB Environment **Chapter 3. MAAB Guidelines** • MATLAB Automotive Advisory Board Process Overview • Simulation & Code Generation **Chapter 4. Introduction to Autosar** • Autosar Basics • Autosar Software Components & Application Layer **Chapter 5. Automotive Functional Safety & ISO26262 - 1** • Automotive Functional Safety Concepts • Overview of ISO26262 **Workshop & Projects:** Workshop using **Matlab- Simulink** to run Automotive Application examples: 1.Using a Data Dictionary to Manage the Data for a Fuel Control System 2.Simulate Simple Driving Scenario and Sensor in Unreal Engine Environment 3. Modelling an Automatic Transmission Controller Students will work in Laboratory on group base project that will be supervised by the Teacher.
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	MathWorks www.mathworks.org

U5.5 ElectiveUnit 2 : Automotive Embedded System

U5.5.2 Elective Module 2: Autonomous Vehicle System

Module designation	Automotive Embedded System
Module level, if applicable	3rd year of engineering Cycle
Code, if applicable	U5.5
Subtitle, if applicable	-
Courses, if applicable	Autonomous Vehicle Systems
Semester (s) in which the module is taught	Semester 5
Person responsible for the module	Dept. Head Emna Rabhi
Lecturer	Dr Lahbib Younes
Language	**English**
Relation to curriculum	Elective Professional Module
Type of teaching, contact hours	21 Workshop 21 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	Electronics, robotics, Linear algebra, Calculus
Module objectives/intended learning outcomes	**Objectives:** Introduction to Autonomous Automotive systems Understand car vehicle motion & lateral, Longitudinal control techniques using Matlab-Simulink Models **Learning Outcomes:** At the end of the course, the student have the ability to: **1.** Simulate & Analyse Longitudinal Controller Stanley **2.** Simulate & Analyse Lateral Controller Stanley

Content	**Contents** **Chapter 1. Introduction to The Requirements for Autonomy** -Driving Tasks -Driving Environment **Chapter 2.Vehicle Longitudinal Control** - Tracking a speed profile along a fixed path, - Control techniques & Accuracy - Dynamic motions. **Chapter 3: Vehicle Lateral Control** -Tracking of fixed path -Geometric control model -Predictive Control Model **Workshop & Projects:** Workshop using **Matlab- Simulink** to run Controller examples: 1. **Longitudinal Controller Stanley** 2. **Lateral Controller Stanley** Students will work in Laboratory on group base project that will be supervised by the Teacher.
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	MathWorks www.mathworks.org

U5.6: Management

U5.6.1: Business Intelligence

Module designation	**Management**
Module level, if applicable	**Year 3, Semester 1**
Code, if applicable	U5.6
Subtitle, if applicable	
Courses, if applicable	**Business Intelligence**
Semester(s) in which the module is taught	Semester 5
Person responsible for the module	Dr Emna RABHI
Lecturer	Aida ben Salem
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	21 hours workshop/ 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	Object Oriented programming, Databases, Numerical Analysis
Module objectives/intended learning outcomes	**Objectives:** 1. Understand Business Intelligence and its use in management 2. Learn about Business Intelligence and its components 3. Description of Data Warehouses 4. Understand Decision-making projects and tools

Content	**Chapter I. Introduction to Business Intelligence BI** 1. History and genesis 2. Operational IT vs. Business Intelligence 3. OnLine Analytical Processing OLAP and OnLine Transaction Processing OLTP Applications 4. Business Intelligence Architecture **Chapter II: Principle of a Data Warehouse** 1. Interest 2. Definition 3. Data modelling 4. Example **Chapter III: Data Warehouse DWH Design** 1. Dimensional modelling 2. Star dimensional modelling 3. Star DWH Case Study 4. Dimensional snowflake modelling 5. Flake DWH Case Study 6. Operations on dimensional modelling 7. Decision bus and Constellation 8. Case study of a decision bus in a DWH 9. Data store (Data Mart) **Chapter IV: Feeding a Data Warehouse (ETL)** 1. ETL: Extraction - Transformation - Load 2. Definition 3. Design 4. Tools 5. Example 6. Metadata **Chapter V: Decision-making projects and tools** 1. Business Intelligence project 2. The actors of a project 3. Business Intelligence tools
Study and examination requirements and forms of examination	100 % Workshop/Seminar/ Project evaluation (Oral Exam)
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Video projection
Reading list	✓ Data Science for Business: What you need to know about data mining and data-analytic thinking ✓ Data mining et statistique décisionnelle, Stéphane Tufféry, 5 janvier 2010

U5.6 : Management

U5.6.2 : Industrial Logistics

Module designation	**Management**
Module level, if applicable	**Year 3, Semester 1**
Code, if applicable	U5.6
Subtitle, if applicable	-
Courses, if applicable	**Industrial Logistics**
Semester (s) in which the module is taught	Semester 1
Person responsible for the module	Dr Emna RABHI
Lecturer	Mme Rihab Mechmech
Language	French
Relation to curriculum	Compulsory module ,
Type of teaching, contact hours	21 hours for Workshop in Lab/ 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	-
Module objectives/intended learning outcomes	**Objectives:** 1. To identify the basic concepts: logistics, supply chain and supply chain management. 2. To optimize inventory management. 3. To optimize logistics costs. 4. To evaluate the logistics process within a company. 5. To optimize the industrial jobs scheduling and allocation throughout the production process. **Learning Outcomes:** Students will be able to: 1. Identify the different logistics costs. 2. Optimize the inventory logistics flows. 3. Propose a logistic dashboard. 4. Schedule the various jobs in an industrial process. 5. Optimize production objectives (the total production time, delays, etc.) 6. Optimize the industrial resources exploitation.

Content	**Classroom Lecture and Guided Work** 1 General Introduction to Industrial Logistics - Basic concepts. - Supply chain management. - Supply chain issues. - Supply chain performance. - Decision-making process. - EDI-supply chain. 2 Inventory management - Basic concepts. - Inventory control. - Inventory valuation methods. - The different logistic storage costs. - Inventory management models. - tutorials, group work, and exercises. 3 Logistics Dashboard - Basic concepts. - Characteristics of a dashboard. - Development of a dashboard (key performance indicators "KPIs"). - Tutorials (case studies). 4 Scheduling problems- Single machine and parallel machines -Basic concepts (jobs, resources, types of workshops, etc.). -Classical scheduling problems (objectives and constraints). - Real-life examples. -Complexity of scheduling problems. -Scheduling schemes. - Priority rules (Software: Lekin) and mathematical models. -Heuristics. -Tutorials and Practical exercises.
Study and examination requirements and forms of examination	Written Mid-term Exam (40%)/ Final Exam (60%)
Media employed	Course Material (Hard/ Soft copy) for Classroom & Online (Moodle ULT) Video projection
Reading list	- Yves Pimor, Michel Fender, La logistique : production, distribution, soutien ;5ème édition. - LA LOGISTIQUE, BARBARA LYONNET ET MARIE-PASCALE SENKEL - Ordonnancement, Patrick Esquirol et Pierre Lopez, 1999, Economica.