ⵏ People's Democratic Republic of Algeria
Ministry of Higher Education and Scientific Research

National Education Committee on Science and Technology

HARMONIZATION
Academic Master's Program Offer

National Program

Field	branch	Speciality
Science and Technology	***Automation***	***Automation and Systems***

I – Identity card of Master's program

Entry Requirements

(Indicate the Bachelor's Degree Specializations that Grant Access to the Master's Program)

Branch	Harmonized Master's Program	Bachelor's Degrees Granting Access to the Master's Program	Classification According to Bachelor's Degree Compatibility	Weight Assigned to the Bachelor's Degree
Automation	Automation and systems	Automation	**1**	**1.00**
		Electronic	**2**	**0.80**
		Electrical Engineering	**2**	**0.80**
		Other Bachelor's Degrees in the field ST	**3**	**0.60**

II – Semester organization sheet for teaching

Semester 1

Teaching unit	Courses – Title	Credits	Coefficient	Weekly HV – Lecture	Weekly HV – Directed Work	Weekly HV – Lab	Semester Hour Load (15 weeks)	**Supplementary Work** (15 weeks)	**Assessment method – Continuous**	**Assessment method – Exam**
Fundamental TU Code : UEF 1.1.1 Credits: 10 Coefficients: 5	Multivariable Linear Systems	6	3	3h00	1h30		67h30	82h30	40%	60%
	Signal processing	4	2	1h30	1h30		45h00	55h00	40%	60%
Fundamental TU Code : UEF 1.1.2 Credits: 8 Coefficients: 4	Converter-Machine Association	4	2	1h30	1h30		45h00	55h00	40%	60%
	Optimization	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodology Teaching Unit Code : UEM 1.1 Credits: 11 Coefficients: 7	Identification Techniques	3	2	1h30		1h00	37h30	37h30	40%	60%
	Multivariable Linear Systems Lab	2	1			1h30	22h30	27h30	100%	
	Signal Processing Lab / Optimization Lab	2	1			1h30	22h30	27h30	100%	
	Converter-Machine Association Lab	2	1			1h30	22h30	27h30	100%	
	Advanced program in Python	2	2	1h30		1h30	45h00	55h00	40%	60%
Discovery TU Code : UED 1.1 Credits : 1 Coefficients : 1	Elective courses	1	1	1h30			22h30	02h30		100%

Total Semester 1		**30**	**17**	**12h00**	**6h00**	**7h30**	**382h30**			

Semester 2

Teaching unit	Courses	Credits	Coefficient	Weekly HV			Semester Hour Load (15 weeks)	**Supplementary Work** (15 weeks)	**Assessment method**	
	Title			**Lecture**	**Directed Work**	**Lab**			**Continuous**	**Exam**
Fundamental TU Code : UEF 1.2.1 Credits : 10 Coefficients : 5	Nonlinear Systems	6	3	3h00	1h30		67h30	82h30	40%	60%
	Optimal Control	4	2	1h30	1h30		45h00	55h00	40%	60%
Fundamental TU Code : UEF 1.2.2 Credits : 8 Coefficients : 4	Applied Electronics	4	2	1h30	1h30		45h00	55h00	40%	60%
	PLC and supervision	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodology Teaching Unit Code : UEM 1.2 Credits : 9 Coefficients : 5	Concepts and Graphical Programming Language	3	2	1h30		1h00	37h30	37h30	40%	60%
	Nonlinear Systems Lab/ Optimal Control Lab	2	1			1h30	22h30	27h30	100%	
	Applied Electronics Lab	2	1			1h30	22h30	27h30	100%	
	PLC and supervision Lab	2	1			1h30	22h30	27h30	100%	

Transversale TU Code : UET 1.2 Credits : 3 Coefficients : 3	Element of applied AI	2	2	1h30	1h30	45h00	5h00	40%	60%	2
	Adherence to Standards, Ethics, and Integrity Guidelines	1	1	1h30			22h30	02h30		100%
Total Semester 2		**30**	**17**	**12h00**	**6h00**	**7h30**	**382h30**			

Semester 3

Teaching unit	Courses	Credits	Coefficient	Weekly HV			Semester hour Load (15 weeks)	**Supplementary Work** (15 weeks)	**Assessment method**	
	Title			**Lecture**	**Directed Work**	**Lab**			**Continuous**	**Exam**
Fundamental TU Code : UEF 2.1.1 Credits : 10 Coefficients : 5	Predictive and Adaptive Control	6	3	3h00	1h30		67h30	82h30	40%	60%
	Intelligent Control	4	2	1h30	1h30		45h00	55h00	40%	60%
Fundamental TU Code : UEF 2.1.2 Credits : 8 Coefficients : 4	System Diagnostics	4	2	1h30	1h30		45h00	55h00	40%	60%
	Manipulation Robot Control	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodology TU Code : UEM 2.1 Credits : 9 Coefficients : 5	Real-Time Systems	3	2	1h30		1h00	37h30	37h30	40%	60%
	Predictive and Adaptive Control Lab/ Intelligent Control Lab	2	1			1h30	22h30	27h30	100%	

	System Diagnostics Lab	2	1			1h30	22h30	27h30	100%	
	Manipulation Robot Control Lab	2	1			1h30	22h30	27h30	100%	
Transversale TU Code : UET 2.1 Credits : 3 Coefficients : 3	Reserve engineering	2	2	1h30	1h30 Atelier		45h00	5h00	40%	60%
	Documentary Research and Dissertation Design	1	1	1h30			22h30	02h30		100%
Total Semester 3		**30**	**17**	**12h00**	**6h00**	**7h30**	**382h30**			

Semeter 4

Internship in a company or research laboratory, culminating in the submission of a thesis and an oral defense.

	SCH	Coeff	Credits
Personal Work	550	09	18
Internship in a company or research laboratory	100	04	06
Seminars	50	02	03
Other (Supervision)	50	02	03
Total Semester 4	750	17	30

This table is provided for informational purposes only

Evaluation of the Master's Final Year Project

- Scientific Merit (Jury Assessment) /6
- Dissertation writing (Jury Assessment) /4
- Oral Presentation and Responses to Questions (Jury Assessment) /4
- Supervisor's Assessment /3
- Internship Report Presentation (Jury Assessment) /3

III – Detailed Course Program for Semester S1

Semester: 1
Teaching Unit: UEF 1.1.1
Course Title: Multivariable Linear Systems
Semester Contact Hours: 67h30 (Lectures: 3h00, Tutorials: 1h30)
Credits: 6
Coefficient: 3

Course Objectives

The aim of this course is to provide a methodology for designing various control laws for multivariable linear time-invariant systems, within the framework of the state-space approach.

Recommended Prerequisites

Students are expected to have prior knowledge of:

- Linear control systems
- Sampled-data systems

Course Content

- **Chapter 1. Introduction** (2 weeks)
- **Chapter 2. State-Space Representation of Multivariable Systems** (2 weeks)
- **Chapter 3. Controllability and Observability** (2 weeks)
- **Chapter 4. Representation of MVS by Transfer Matrix** (3 weeks)
- **Chapter 5. State-Feedback Control of MVS** (4 weeks)

Assessment Method

- Continuous assessment: 40%
- Final exam: 60%

Semester: 1
Teaching Unit: UEF 1.1.1
Course Title: Signal Processing
Semester Contact Hours: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Course Objectives:
Master the tools for time-domain and frequency-domain representation of analog and digital signals and systems, and perform basic signal processing tasks such as filtering and digital spectral analysis.

Recommended Prerequisites:
Students should have prior knowledge of:

- Signal theory
- Fundamental mathematics

Course Content:

- **Chapter 1:** Review of Fundamental Results of Signal Theory — (2 weeks)
- **Chapter 2:** Analysis and Synthesis of Analog Filters — (4 weeks)
- **Chapter 3:** Signal Sampling — (1 week)
- **Chapter 4:** Discrete Transforms and Windowing Techniques — (3 weeks)
- **Chapter 5:** Analysis and Synthesis of Digital Filters — (5 weeks)

Assessment Method:

- Continuous assessment: 40%
- Final exam: 60%

Semester: 1
Teaching Unit: UEF 1.1.2
Course Title: Converter-Machine Association
Semester Contact Hours: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Course Objectives:
To study the different converter–electric rotating machine configurations in order to control the torque and speed of a system.

Recommended Prerequisites:
Students should have prior knowledge of:

- Power electronics

Course Content:

- **Chapter 1:** DC–AC Converters — (4 weeks)
- **Chapter 2:** DC Motors — (2 weeks)
- **Chapter 3:** AC Motors — (2 weeks)
- **Chapter 4:** Converter–Machine Associations — (4 weeks)
- **Chapter 5:** Selection Criteria and Implementation of Variable-Speed Drives — (3 weeks)

Assessment Method:

- Continuous assessment: 40%
- Final exam: 60%

Semester: 1
Teaching Unit: UEF 1.1.2
Course Title: Optimization
Semester Contact Hours: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Course Objectives:

The objective of this course is to master complex optimization techniques encountered in the management of large production systems, machines, and materials in industry, commerce, and administration. The goal is to provide decision-making support to achieve maximum performance.

Recommended Prerequisites:
Students should have prior knowledge of:

- Mathematics

Course Content:

- **Chapter 1:** Mathematical Recap — (2 weeks)
- **Chapter 2:** Unconstrained Optimization – Local Methods — (3 weeks)
- **Chapter 3:** Unconstrained Optimization – Global Methods — (3 weeks)
- **Chapter 4:** Linear Programming — (3 weeks)
- **Chapter 5:** Nonlinear Programming — (4 weeks)

Assessment Method:

- Continuous assessment: 40%
- Final exam: 60%

Semester: 1
Teaching Unit: UEM 1.1
Course Title: Identification Techniques
Semester Contact Hours: 45h00 (Lectures: 1h30, Lab: 1h30)
Credits: 3
Coefficient: 2

Course Objectives:

This course enables students to master modern control techniques for system identification and model estimation, covering both theoretical principles and practical implementation through numerous examples.

Recommended Prerequisites:
Students should have prior knowledge of:

- Power electronics

Course Content:

- **Chapter 1:** Review – Equation Error-Based Identification — (2 weeks)
- **Chapter 2:** Instrumental Variable Method — (2 weeks)
- **Chapter 3:** Prediction Error Method — (5 weeks)
- **Chapter 4:** Closed-Loop Identification — (1 week)
- **Chapter 5:** Practical Aspects of Identification — (3 weeks)
- **Chapter 6:** Model Validation — (2 weeks)

Laboratory Sessions – Identification Techniques:

- **Lab 1:** Least Squares Method
- **Lab 2:** Instrumental Variable Method
- **Lab 3:** Prediction Error Method
- **Lab 4:** Prediction Error Method
- **Lab 5:** Closed-Loop Identification
- **Lab 6:** Model Validation

Assessment Method:

- Continuous assessment: 40%
- Final exam: 60%

Semester: 1
Teaching Unit: UEM 1.1
Course Title: Lab – Multivariable Linear Systems
Semester Contact Hours: 22h30 (Lab: 1h30)
Credits: 2
Coefficient: 1

Course Objectives:

The objective of this course is to provide a methodology for designing various control laws for multivariable linear time-invariant systems, specifically state-feedback and output-feedback control.

Recommended Prerequisites:
Students should have prior knowledge of:

- Linear algebra
- Multivariable linear control systems

Laboratory Sessions:

- **Lab 1:** Introduction to MATLAB
- **Lab 2:** State-Space Representation of Multivariable Systems
- **Lab 3:** Controllability and Observability
- **Lab 4:** Representation of Multivariable Systems via Transfer Matrix
- **Lab 5:** State-Feedback Control of Multivariable Systems
- **Lab 6:** State Observation of Multivariable Systems

Assessment Method:

- 100% Continuous Assessment

Semester: 1
Teaching Unit: UEM 1.1
Course Title: Signal Processing Lab / Optimization Lab
Semester Contact Hours: 22h30 (Lab: 1h30)
Credits: 2
Coefficient: 1

Course Objectives:

- **Signal Processing Lab:** Consolidate the knowledge acquired during the "Signal Processing" course through practical exercises to better understand and assimilate the course content.
- **Optimization Lab:** Enable students to apply and master the theoretical concepts studied in the course.

Recommended Prerequisites:

- Prior knowledge from the corresponding theoretical courses (Signal Processing, Optimization)

Laboratory Sessions – Signal Processing:

- **Lab 1:** Signal representation and applications of the Fourier Transform using MATLAB
- **Lab 2:** Analog Filtering
- **Lab 3:** Discrete Fourier Transform
- **Lab 4:** IIR Digital Filtering
- **Lab 5:** FIR Digital Filtering

Laboratory Sessions – Optimization:

- **Lab 1:** Introduction to MATLAB
- **Lab 2:** Unconstrained Optimization
- **Lab 3:** Unconstrained Optimization
- **Lab 4:** Linear Programming
- **Lab 5:** Nonlinear Programming

Assessment Method:

- 100% Continuous Assessment

Semester: 1
Teaching Unit: UEM 1.1
Course Title: Converter-Machine Association Lab
Semester Contact Hours: 22h30 (Lab: 1h30)
Credits: 2
Coefficient: 1

Course Objectives

This laboratory course enables students to apply and consolidate the knowledge acquired in the module Converter–Machine Association.

Recommended Prerequisites:

- Course Content

Laboratory Content

- **Lab 1:** DC–AC Converters
- **Lab 2:** Variable-Speed Drive for DC Motors
- **Lab 3:** Variable-Speed Drive for AC Motors
- **Lab 4:** Variable-Speed Drive for Synchronous Machines
- **Lab 5:** Variable-Speed Drive for Asynchronous (Induction) Machines

Assessment Method:

- 100% Continuous Assessment

Semester: 1
Teaching Unit: UEM 1.1
Course Title: Advanced Python Programming
Semester Contact Hours: 45h00 (Lectures: 1h30, Lab: 1h30)
Credits: 2
Coefficient: 2

Course Objectives

- **Targeted Competencies:**

- Use of digital tools for the acquisition, processing, production, and dissemination of information.
- Proficiency in Python programming and project management.
- Skills in automation and data visualization.

- **Objectives:**

- To deepen proficiency in the Python programming language and introduce students to the fundamentals of data analysis and artificial intelligence.
- To acquire solid foundational knowledge in computer science.
- To develop programming skills in Python and Excel.
- To master task automation techniques.
- To gain proficiency in project management software

Recommended Prerequisites

- Python Programming

Course Content

- **Chapter 1:** Review of Python Programming — (2 weeks)
- **Chapter 2:** Programming and Automation — (4 weeks)
- **Chapter 3:** Advanced Excel Training — (2 weeks)
- **Chapter 4:** Introduction to GanttProject — (2 weeks)
- **Chapter 5:** Advanced Object-Oriented Programming — (3 weeks)
- **Chapter 6:** Introduction to Data for Artificial Intelligence — (2 weeks)

Laboratory Sessions

- **Lab 1:** Mastering Python Programming Fundamentals
- **Lab 2:** Developing a specification document for a mini task-automation project using Python (automatic report generation and email sending)…
- **Lab 3:** Excel dashboard programming (based on tutorial sessions)…
- **Lab 4:** Organizing a meeting using GanttProject
- **Lab 5:** Advanced structures and code organization
- **Lab 6:** Advanced Object-Oriented Programming in Python
- **Lab 7:** File handling and data analysis
- **Lab 8:** Data preparation and preprocessing for artificial intelligence

Final Project

Title: Data Analysis and Visualization with a Simple Predictive Model

Skills Applied:

- Data reading and manipulation
- Object-Oriented Programming (OOP)
- Advanced data structures
- Use of Pandas and Scikit-learn libraries
- Oral presentation and written report

Assessment Method

- Final Exam: 60%
- Continuous Assessment: 40%

III – Detailed Program by Course for Semester S2

Semester: 2
Teaching Unit: UEF 1.2.1
Course Title: nonlinear systems
Semester Contact Hours: 67h30 (Lectures: 3h00, Tutorials: 1h30)
Credits: 6
Coefficient: 3

Course Objectives

The objective of this course is to raise students' awareness of stability issues in nonlinear systems and to provide them with mathematical tools for analysis. It also aims to introduce nonlinear control methods, such as techniques based on differential geometry and sliding mode approaches. The methodologies presented utilize both time-domain and frequency-domain representations

Recommended Prerequisites:

Students are expected to have prior knowledge in:

- Signal Theory
- Fundamental Mathematics

Course Content:

- **Chapter 1:** Introduction (1 week)
- **Chapter 2:** Phase Plane Analysis (3 weeks)
- **Chapter 3:** First Harmonic Method (3 weeks)
- **Chapter 4:** Foundations of Lyapunov Theory (2 weeks)
- **Chapter 5:** Passivity Theory (2 weeks)
- **Chapter 6:** Concepts of Differential Geometry (3 weeks)
- **Chapter 7:** Control of Nonlinear Systems (3 weeks)

Assessment Method:

Continuous Assessment: 40%
Final Examination: 60%

Semester: 2
Teaching Unit: UEF 1.2.1
Course Title: Optimal Control
Semester Contact Hours: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Course Objectives:

The objective of this course is to present the theoretical and numerical aspects of optimal control, as well as its applications in various fields.

Recommended Prerequisites:

Students are expected to have prior knowledge in:

- Linear Control Systems
- Sampled-Data Systems

Course Content:

- **Chapter 1:** Introduction: The Optimal Control Problem (1 week)
- **Chapter 2:** Minimum-Time Control (3 weeks)
- **Chapter 3:** Linear Quadratic Control (4 weeks)
- **Chapter 4:** Linear Quadratic Gaussian Control (4 weeks)
- **Chapter 5:** Numerical Methods in Optimal Control (3 weeks)

Assessment Method:

Continuous Assessment: 40%
Final Examination: 60%

Semester: 2
Teaching Unit: UEF 1.2.2
Course Title: Applied Electronics
Semester Contact Hours: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Course Objectives:

This course aims to introduce students to additional fundamental functions of electronics. Initially, students should be able to identify the type and function of an electronic component within a complete system, including industrial applications. They should then be capable of performing measurements on electronic circuits, including modifications and troubleshooting. Finally, students should be able to propose solutions to problem-based situations through the design and implementation of analog electronic circuits.

Recommended Prerequisites:

Students are expected to have prior knowledge in:

- Fundamental Electronics
- Power Electronics

Course Content:

- **Chapter 1:** Review of Transistor Switching Operation and Capacitor Charging/Discharging (1 week)
- **Chapter 2:** Operational Amplifiers and Op-Amp-Based Circuits (2 weeks)
- **Chapter 3:** Pulse (Signal) Generation (3 weeks)
- **Chapter 4:** Analog-to-Digital (ADC) and Digital-to-Analog (DAC) Converters (3 weeks)
- **Chapter 5:** Study of Active Filters (2 weeks)
- **Chapter 6:** Introduction to Printed Circuit Board (PCB) Design Principles (4 weeks)

Assessment Method:

Continuous Assessment: 40%
Final Examination: 60%

Semester: 2
Teaching Unit: UEF 1.2.2
Course Title: PLC and Supervision
Semester Contact Hours: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Course Objectives:

By the end of this course, students should be able to define the programming and supervision tools required to implement a control automation system based on a specification. They should be able to select the necessary hardware and configuration, design a program, and implement an industrial automation system.

Recommended Prerequisites:

Students are expected to have prior knowledge in:

- Industrial Programmable Logic Controllers (PLCs)
- Programming

Course Content:

- **Chapter 1:** Industrial Programmable Logic Controllers (3 weeks)
- **Chapter 2:** Programming Languages: IEC 61131-3 Standard (5 weeks)
- **Chapter 3:** Blocks and Functions (3 weeks)
- **Chapter 4:** Human-Machine Interface (HMI) and Supervision (4 weeks)

Assessment Method:

Continuous Assessment: 40%
Final Examination: 60%

Semester: 2
Teaching Unit: UEM 1.2
Course Title: Concepts and Graphical Programming Language
Semester Contact Hours: 45h00 (Lectures: 1h30, Lab: 1h30)
Credits: 3
Coefficient: 2

Course Objectives:

This course enables students to become familiar with the LabVIEW graphical programming environment and its basic functionalities, in order to develop applications for data acquisition and instrument control.

Recommended Prerequisites:

Students are expected to have prior knowledge in:

- Basic programming concepts

Course Content:

- **Chapter 1:** Introduction to LabVIEW Virtual Instruments (VIs)…
- **Chapter 2:** Customization of a VI (2 weeks)
- **Chapter 3:** Signal Analysis and Recording (2 weeks)
- **Chapter 4:** Hardware: Data Acquisition and Instrument Communication (Windows) (2 weeks)
- **Chapter 5:** Loops, Shift Registers, Introduction to Graphs, Arrays and Files, Array and Graph Functions (4 weeks)
- **Chapter 6:** Strings, Clusters, Error Handling, Conditional and Sequence Structures, Formula Node, and Variables (3 weeks)

Lab Sessions (TP LabVIEW):

- **TP1:** Introduction to Programming in LabVIEW
- **TP2:** Calculations in LabVIEW
- **TP3:** Signal Acquisition and Generation
- **TP4:** Loops and Structures
- **TP5:** Arrays and Graphs
- **TP6:** Strings and Clusters
- **TP7:** Communication with an Instrument

Assessment Method:

Continuous Assessment: 40%
Final Examination: 60%

Semester: 2
Teaching Unit: UEM 1.2
Course Title: Nonlinear Systems Lab / Optimal Control Lab
Semester Contact Hours: 22h30 (Lab: 1h30)
Credits: 2
Coefficient: 1

Course Objectives:

- **Nonlinear Systems:**

- Demonstrate the difference between the dynamic behavior of linear and nonlinear systems.
- Introduce the concept of equilibrium points.
- Illustrate the usefulness of the phase plane through simulation.
- Synthesize nonlinear systems.

- **Optimal Control:**

- Enable students to apply and master the theoretical concepts studied in class.

Recommended Prerequisites:

- Matlab/Simulink
- Basic principles of physics for modeling mechanical, electrical, hydraulic, pneumatic, and robotic systems

Course Content:

- **Nonlinear Systems:**

- **TP1:** Advanced simulations in Matlab
- **TP2:** Simulation of equilibrium points of selected nonlinear systems
- **TP3:** Simulation of selected nonlinear systems in the phase plane
- **TP4:** Open-loop simulation of the inverted pendulum
- **TP5:** Simulation of feedback linearization control
- **TP6:** Sliding Mode Control

- **Optimal Control:**

- **TP1:** Introduction to Matlab
- **TP2:** State-feedback control and observers
- **TP3:** Minimum-time optimal control
- **TP4:** Linear-Quadratic Control, applications in regulation
- **TP5:** Numerical methods in optimal control

Assessment Method:

100% Continuous Assessment

Semester: 2
Teaching Unit: UEM 1.2
Course Title: Lab Applied Electronics
Semester Contact Hours: 22h30 (Lab: 1h30)
Credits: 2
Coefficient: 1

Course Objectives:

The aim of the practical sessions is to provide students with the opportunity to assemble electronic circuits on a breadboard and then validate their operation using measurement instruments.

Recommended Prerequisites:

- Course content.

Course Content:

- **TP1:** Study of Field-Effect Transistor (FET) and MOS Amplifiers
- **TP2:** Operational Amplifiers
- **TP3:** Study of an example ADC and DAC circuit
- **TP4:** Oscillators
- **TP5:** Active Filters (low-pass, high-pass, etc.)
- **TP6:** Implementation of an electronic circuit

Both the course instructor and students may propose additional circuit realizations.

Assessment Method:

100% Continuous Assessment

Semester: 2
Teaching Unit: UEM 1.2
Course Title: Lab - PLC and Supervision
Semester Contact Hours: 22h30 (Lab: 1h30)
Credits: 2
Coefficient: 1

Course Objectives:

This lab will allow students to put into practice and consolidate the knowledge acquired in the PLC and Supervision module.

Recommended Prerequisites:

- Course content.

Course Content:

- Practical sessions will be planned according to the available hardware.

Assessment Method:

100% Continuous Assessment

Semester: 2
Teaching Unit: UEM 1.2
Course Title: Fundamentals of Applied Artificial Intelligence
Semester Contact Hours: 45h30 (Lectures: 1h30, Lab: 1h30)
Credits: 2
Coefficient: 2

Targeted Competencies:

- Identify opportunities for Artificial Intelligence (AI) in engineering sciences.
- Understand the ethical implications of AI and best practices for its use.
- Ability to apply Artificial Intelligence techniques to problem solving.

Course Objectives:

- Master AI algorithms.
- Gain an introduction to the fundamental concepts, tools, and applications of modern AI, with an emphasis on practical implementation using Python and its libraries.
- Deepen Python programming skills.
- Understand AI approaches in problem-solving.

Recommended Prerequisites:

- Advanced Python programming

Course Content:

- **Chapter 1:** Introduction to Artificial Intelligence (AI) (1 week)
- **Chapter 2:** Basic Mathematics for AI (1 week)
- **Chapter 3:** Machine Learning (3 weeks)
- **Chapter 4:** Supervised Classification (3 weeks)
- **Chapter 5:** Unsupervised Learning
- **Chapter 6:** Neural Networks
- **Chapter 7:** Mini Project (supervised individual work outside class)

Practical Sessions (TP):

- **Lab01:** Initialization
- **Lab2:** Implement a simple regression with Scikit-learn and visualize results with Matplotlib
- **Lab3:** Machine learning pipeline and data splitting
- **Lab4:** Use Scikit-learn to train a simple classification model
- **Lab5:** Implement a clustering algorithm on a dataset
- **Lab6:** Build a simple neural network using TensorFlow, PyTorch, or Keras

Assessment Method:

- Final Exam: 60%
- Continuous Assessment: 40%

Semester: 2
Teaching Unit: UET 1.2
Course Title: Ethical and Integrity Standards Compliance
Semester Contact Hours: 22h30 (Lectures: 1h30)
Credits: 1
Coefficient: 1

Course Objectives:

Develop students' awareness of ethical principles and rules governing university life and the workplace.

- Raise awareness of respect for and the promotion of intellectual property.
- Explain the risks of moral misconduct, such as corruption, and ways to combat them.
- Alert students to ethical issues arising from new technologies and sustainable development.

Recommended Prerequisites:

- Ethics and Professional Conduct (fundamentals)

Course Content:

A. Respect for Ethics and Integrity

1. Overview of the MESRS Ethics and Professional Conduct Charter
2. Responsible and Integrity-based Research
3. Ethics and Professional Conduct in the Workplace

B. Intellectual Property

1. Fundamentals of Intellectual Property
2. Copyright Law
3. Protection and Valorization of Intellectual Property

C. Ethics, Sustainable Development, and New Technologies

Assessment Method:

- Exam: 100%

III – Detailed Program by Course for Semester S3

Semester: 3
Teaching Unit: UEF 2.1.1
Course Title: Predictive and adaptive control
Semester Contact Hours: 67h30 (Lectures: 3h00, Tutorials: 1h30)
Credits: 6
Coefficient: 3

Course Objectives:

This course is composed of two parts. The first part focuses on Predictive Control**,** presenting the different types of predictive control and their implementation. The second part covers Adaptive Control, introducing the essential elements required for its implementation.

Recommended Prerequisites:

- Linear Feedback Control Systems
- Nonlinear Feedback Control Systems

Course Content:

- **Predictive Control**

- **Chapter 1:** Principles of Predictive Control (1 week)
- **Chapter 2:** Generalized Predictive Control (3 weeks)
- **Chapter 3:** Model-Based Predictive Control (3 weeks)

- **Adaptive Control**

- **Chapter 1:** Various Methods of Adaptive Control (3 weeks)
- **Chapter 2:** Implementation of Adaptive Control (3 weeks)
- **Chapter 3:** Identification in Adaptive Control (2 weeks)

Assessment Method:

- Continuous Assessment: 40%
- Final Exam: 60%

Semester: 3
Teaching Unit: UEF 2.1.1
Course Title: Intelligent Control
Semester Contact Hours: 45h00 (Lectures: 3h00, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Course Objectives:

Introduce the methods and tools necessary for integrating fuzzy logic and neural networks into industrial process identification and control schemes. Provide the essential theoretical foundation for understanding these approaches and their application in analysis, design, and implementation phases.

Recommended Prerequisites:

- Linear feedback Control Systems
- Sampled-Data Systems

Course Content:

- **Part I: Fuzzy Logic**

- **Chapter 1:** Introduction to Fuzzy Set Theory (1 week)
- **Chapter 2:** Fuzzy Reasoning (1 week)
- **Chapter 3:** Fuzzy Modeling and Fuzzy Inference Systems (2 weeks)
- **Chapter 4:** Fuzzy Control (3 weeks)

- **Part II: Neural Networks**

- **Chapter 1:** Introduction to Neural Networks (1 week)
- **Chapter 2:** Modeling (McCulloch-Pitts model, general modeling, perceptron, learning algorithms/techniques) (3 weeks)
- **Chapter 3:** Multilayer Networks (3 weeks)
- **Chapter 4:** Applications of Neural Networks (1 week)

Assessment Method:

- Continuous Assessment: 40%
- Final Exam: 60%

Semester: 3
Teaching Unit: UEF 2.1.2
Course Title: Control of Robotic Manipulators
Semester Contact Hours: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Course Objectives:

This course aims to enable students to master modeling tools and control techniques for robotic manipulators. It provides students with the ability to independently solve fundamental robotics problems such as configuration (kinematics), trajectory generation, and dynamic control.

Recommended Prerequisites:

- Linear Control Systems and Feedback Control
- Basic knowledge of kinematics and dynamics

Course Content:

- **Chapter I.** Introduction (1 week)
- **Chapter II.** Theoretical and Mathematical Foundations (2 weeks)
- **Chapter III.** Modeling of a Robotic Manipulator (3 weeks)
- **Chapter IV.** Trajectory Generation (3 weeks)
- **Chapter V.** Robot Control (3 weeks)
- **Chapter VI.** Robot Programming (3 weeks)

Assessment Method:

- Continuous Assessment: 40%
- Final Examination: 60%

Semester: 3
Teaching Unit: UEF 2.1.2
Course Title: System Diagnosis
Semester Contact Hours: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Course Objectives:

The objective of this course is to study the different fault diagnosis methods, focusing on fault detection and isolation (FDI). Both model-based and model-free approaches will be presented. The course also explains how system performance can be enhanced by improving the reliability of dynamic systems.

Recommended Prerequisites:

Students should have prior knowledge of:

- Continuous-time control systems
- Sampled-data (discrete-time) systems

Course Content:

- **Chapter 1:** General Concepts and Definitions (1 week)
- **Chapter 2:** Diagnostic Methods (3 weeks)
- **Chapter 3:** Residual Generation Using State Observers (3 weeks)
- **Chapter 4:** Residual Generation Using the Parity Space Approach (3 weeks)
- **Chapter 5:** Diagnosis by Parametric Identification (3 weeks)
- **Chapter 6:** Residual Analysis (2 weeks)

Assessment Method:

- Continuous Assessment: 40%
- Final Examination: 60%

Semester: 3
Teaching Unit: UEM 2.1
Course Title: Real-Time Systems
Semester Contact Hours: 45h00 (Lectures: 1h30, Tutorials: 1h30)
Credits: 3
Coefficient: 2

Course Objectives:

The objective of this course is to introduce the fundamental concepts that enable students to:

- Analyze the requirements of a real-time problem
- Design an appropriate solution
- Demonstrate the correctness of the proposed design
- Implement the solution through programming
- Validate the implemented solution
- Develop applications on a real-time system

Recommended Prerequisites:

Students should have prior knowledge of:

- Fundamentals of microprocessor operation
- Programming in C language

Course Content:

Chapter 1: Introduction to Real-Time Systems (2 weeks)
Chapter 2: Architecture and Operation of a Real-Time Kernel (3 weeks)
Chapter 3: Specification Techniques for Real-Time Systems (3 weeks)
Chapter 4: Concurrent Programming (3 weeks)
Chapter 5: Real-Time Programming Languages (4 weeks)

Laboratory Work (LabVIEW):

- **Lab 1:** Introduction to Programming
- **Lab 2:** Task Management
- **Lab 3:** Interrupts, Signals, and Events
- **Lab 4:** Scheduling
- **Lab 5:** Synchronization and Communication
- **Lab 6:** Time Management

Assessment Method:

- Continuous Assessment: 40%
- Final Examination: 60%

Semester: 3
Teaching Unit: UEM 2.1
Course Title: Lab- Predictive and Adaptive Control / Intelligent Control
Semester Contact Hours: 22h30 (Lab: 1h30)
Credits: 2
Coefficient: 1

Course Objectives:

The objective of this laboratory course is to enable students to apply and master the theoretical concepts studied in lectures through practical implementation and simulation.

Recommended Prerequisites:

- Course content
- MATLAB/Simulink

Laboratory Content
I. Predictive and Adaptive Control

- **Lab 1:** Generalized Predictive Control (GPC)
- **Lab 2:** State-Space Model Predictive Control
- **Lab 3:** Functional Predictive Control
- **Lab 4:** Gain-Scheduled Control and Self-Tuning Control
- **Lab 5:** Direct and Indirect Adaptive Control
- **Lab 6:** Closed-Loop Adaptive Control

II. Intelligent Control

- **Lab 1:** Modeling of a Dynamic System Using Fuzzy Logic
- **Lab 2:** Fuzzy Control of a Dynamic System
- **Lab 3:** Fuzzy PID Control of a Dynamic System
- **Lab 4:** Modeling of a Dynamic System Using Neural Networks
- **Lab 5:** Neural Control of a Dynamic System
- **Lab 6:** Multilayer Neural Network Control of a Dynamic System

Assessment Method:

- Continuous Assessment: 100%

Semester: 3
Teaching Unit: UEM 2.1
Course Title: Lab- System Diagnosis
Semester Contact Hours: 22h30 (Lab: 1h30)
Credits: 2
Coefficient: 1

Course Objectives:

The objective of these laboratory sessions is to provide students with the opportunity to introduce and apply the fundamental concepts of fault detection and diagnosis in complex systems. Students will implement various automatic diagnostic methods that have proven effective in different practical applications.

Recommended Prerequisites:

- Course content

Laboratory Content

- **Lab 1:** System Development and Adaptation for Diagnostic Purposes
- **Lab 2:** Fault Detection Using a Luenberger Observer
- **Lab 3:** Fault Detection and Isolation Using Unknown Input Observer (UIO) Banks
- **Lab 4:** Residual Generation by Analytical Redundancy
- **Lab 5:** Diagnosis by Parametric Identification
- **Lab 6:** Residual Analysis Using the Page–Hinkley Test

Assessment Method:

- Continuous Assessment: 100%

Semester: 3
Teaching Unit: UEM 2.1
Course Title: Lab- Control of Robotic Manipulators
Semester Contact Hours: 22h30 (Lab: 1h30)
Credits: 2
Coefficient: 1

Course Objectives:

The objective of these laboratory sessions is to provide practical implementation and a concrete understanding of the concepts studied in the course *"Control of Robotic Manipulators."* Through hands-on work, students will better understand and assimilate the theoretical content of the module.

Recommended Prerequisites:

- Course content

Laboratory Content:

- **Lab 1:** Introduction to MATLAB Robotics Toolbox (Geometric Transformations)
- **Lab 2:** Geometric Modeling and Inverse Kinematics of a Planar Robot (3 DOF)
- **Lab 3:** Forward and Inverse Kinematic Modeling
- **Lab 4:** Dynamic Modeling of a Planar Robot (2 DOF)
- **Lab 5:** Trajectory Generation in Joint Space and Cartesian Space
- **Lab 6:** Dynamic Control of a Robot

Assessment Method:

- Continuous Assessment: 100%

Semester: 3
Teaching Unit: UET 2.1
Course Title: Reverse Engineering
Semester Contact Hours: 45h00 (Lectures: 1h30, Workshop: 1h30)
Credits: 2
Coefficient: 2

Course Objectives

- To understand the principles and objectives of Reverse Engineering (RE) within the field of Science and Technology (ST).
- To gain introductory experience with RE tools and methodologies relevant to the specific discipline.
- To comprehend the value and ethical considerations of RE principles in product design, manufacturing, and quality assurance.
- To foster critical thinking, technical curiosity, structured reverse engineering practices, and innovation.
- To learn how to analyze, document, and model an existing system in the absence of initial documentation.

Targeted Competencies

- Decompose and analyze an existing system.
- Accurately reproduce a technical drawing or 3D model based on an existing product.
- Apply diagnostic and simulation tools.
- Work collaboratively on an exploratory project.
- Identify the legal and regulatory boundaries of reverse engineering practices.

Recommended Prerequisites

- Fundamental knowledge in the relevant specialization.

Course Content

1. Introduction to Reverse Engineering
2. General Methodology
3. Hardware Reverse Engineering
4. Software Reverse Engineering

5. Mechanical Reverse Engineering
6. Security and Intrusion Detection
7. Real-World Case Studies

Practical Work Examples (Based on the Four Engineering Disciplines)

- Electrical Engineering
- Mechanical Engineering
- Civil Engineering
- Process Engineering

Assessment Method

- Technical laboratory sessions
- Reverse engineering mini-project (report + oral defense)
- Final examination (MCQs + case study)
- Final Exam: 60%
- Continuous Assessment (Lab Work): 40%

Semester: 3
Teaching Unit: UET 2.1
Course Title: Research Methodology and Dissertation Preparation
Semester Contact Hours: 22h30 (Lectures: 1h30)
Credits: 1
Coefficient: 1

Course Objectives

To provide students with the necessary tools to search for relevant information and effectively utilize it in their final-year project. To guide them through the various stages leading to the preparation of a scientific document. To emphasize the importance of communication and train them to present their work in a rigorous, structured, and pedagogical manner.

Recommended Prerequisites

- Academic writing methodology
- Presentation methodology

Course Content

Part I: Literature Review and Information Retrieval

Chapter I-1: Topic Definition (02 Weeks)
Chapter I-2: Selection of Information Sources (02 Weeks)
Chapter I-3: Locating Documents (01 Week)
Chapter I-4: Information Processing and Analysis (02 Weeks)
Chapter I-5: Bibliographic Presentation and Referencing (01 Week)

Part II: Thesis/Dissertation Preparation

Chapter II-1: Structure and Stages of Thesis Preparation (02 Weeks)
Chapter II-2: Writing Techniques and Academic Standards (02 Weeks)
Chapter II-3: Workshop: Critical Analysis of a Manuscript (01 Week)
Chapter II-4: Oral Presentations and Thesis Defense (01 Week)
Chapter II-5: How to Avoid Plagiarism (01 Week)

Assessment Method

- Final Examination: 100%