People's Democratic Republic of Algeria الجمهورية الجزائرية الديمقراطية الشعبية
وزارة التعليم العالي والبحث العلمي
Ministry of Higher Education and Scientific Research
اللجنة البيداغوجية الوطنية لميدان العلوم و التكنولوجيا
National Pedagogical Committee of the Science and Technology field

ACADEMIC MASTER's DEGREE HARMONIZES

National Program

Update 2025

Domain	Spinneret	Speciality
Sciences and Technologies	***Electromechanics***	***Mechatronics***

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مواءمة

ماستر أكاديمي

Update 2025

الميدان	الفرع	التخصص
علوم و تكنولوجيا	كهروميكانيك	ميكاترونيك

I – Master's identity sheet

Conditions of access

Spinneret	Harmonized Master's Degree	Access Licenses Master's degree	Classification according to license compatibility	Coefficient assigned to the licence
Electromechanics	Mechatronics	Electromechanics	**1**	**1.00**
		Industrial Maintenance	**1**	**1.00**
		Electronic	**2**	**0.80**
		Automatic	**2**	**0.80**
		Mechanical engineering	**3**	**0.70**
		Other ST Domain Licenses	**5**	**0.60**

II – Semester organisation sheets for teaching of the specialty

Semester 1 Master's Degree: Mechatronics

Teaching unit	Materials — Entitled	Credits	Coefficient	Weekly hours — Course	Weekly hours — Tutorial	Weekly hours — WP	Semi-Annual hourly volume (15 weeks)	Complementary work in Consultation (15 weeks)	Evaluation method — Continuous assessment	Evaluation method — Examination
Core UE Code: UEF 1.1.1 Credits: 10 Coefficients: 5	Applied Electronics	4	2	1h30	1h30		45h00	55h00	40%	60%
	Automatism	4	2	1h30	1h30		45h00	55h00	40%	60%
	Mechanical Design	2	1	1h30			22h30	27h30		100%
Core UE Code: UEF 1.1.2 Credits: 8 Coefficients: 4	Sensors and actuators	4	2	1h30	1h30		45h00	55h00	40%	60%
	Signal processing	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological UE Code: EMU 1.1 Credits: 9 Coefficients: 5	Lab Signal processing	2	1			1h30	22h30	27h30	100%	
	Lab Applied Electronics	2	1			1h30	22h30	27h30	100%	
	Lab Automation	2	1			1h30	22h30	27h30	100%	
	Lab Mechanical Design	2	1			1h30	22h30	27h30	100%	
	Lab Sensors and Actuators	1	1			1h30	22h30	2h30	100%	
	Advanced Python Programming	2	2	1h30		1h30	45h00	55h00	40%	60%
Discovery UE Code: UED 1.1 Credits: 2 Coefficients: 2	Basket of your choice	1	1	1h30			22h30	02:30 am		100%
Semester 1 total		**30**	**17**	**10h30**	**6h00**	**9h00**	**382h30**	**367h00**		

Semester 2 Master's Degree: Mechatronics

Teaching unit	Materials – Entitled	Credits	Coefficient	Weekly hourly volume – Course	Weekly hourly volume – Tutorial	Weekly hourly volume – WP	Semi-Annual Hourly Volume (15 weeks)	Complementary work in Consultation (15 weeks)	Evaluation method – Continuous assessment	Evaluation method – Examination
Core UE Code: UEF 1.2.1 Credits: 10 Coefficients: 5	Robotics and control	4	2	1h30	1h30		45h00	55h00	40%	60%
	Diagnostics by vibration analysis	4	2	1h30	1h30		45h00	55h00	40%	60%
	Non-Destructive Control and Evaluation	2	1	1h30			22h30	27h30		100%
Core UE Code: UEF 1.2.2 Credits: 8 Coefficients: 4	Architecture and programming of programmable logic controllers	4	2	1h30	1h30		45h00	55h00	40%	60%
	Industrial IT	4	2	1h30	1h30		45h00	55:00	40%	60%
Methodological UE Code: EMU 1.2 Credits: 9 Coefficients: 5	Software and Advanced Programming Workshop	3	2	1h30		1h00	45h00	30h00	40%	60%
	Lab Diagnostic by vibration analysis	2	1			1h30	22h30	27h30	100%	
	Lab Non-Destructive Testing and Evaluation	2	1			1H30	22h30	27h30	100%	
	Lab Architecture and programming of industrial programmable logic controllers	2	1			1h30	22h30	27h30	100%	
Transversal UE Code: UED 1.2 Credits: 1 Coefficients: 3	Applied elements of AI	2	2	1h30	1h30		22h30	5h00		100%
	Compliance with the standards and rules of ethics and integrity	1	1	1h30			22h30	02h30		100%
Semester 2 total		**30**	**17**	**12h00**	**6h00**	**7h30**	**382h30**	**367h30**		

Semester 3 Master's Degree: Mechatronics

Teaching unit	Materials	Credits	Coefficient	Weekly hourly volume			Semi-Annual Hourly Volume (15 weeks)	Complementary work in Consultation (15 weeks)	Evaluation method	
	Entitled			**Course**	**Tutorial**	**TP**			**Continuous assessment**	**Examinatio n**
Fondamental UE Code: UEF 2.1.1 Credits: 10 Coefficients: 5	Modeling and diagnosis of mechatronic systems	6	3	3h00	1h30		67h30	82h30	40%	60%
	Fundamental technology of mechatronic elements	4	2	1h30	1h30		45h00	55h00	40%	60%
Fondamental UE Code: UEF 2.1.2 Credits: 8 Coefficients: 4	Embedded systems	4	2	1h30	1h30		45h00	55h00	40%	60%
	Dynamic Systems Control	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological UE Code: EMU 2.1 Credits: 9 Coefficients: 5	Lab Embedded Systems	2	1			1h30	22h30	27h30	100%	
	CAD/CAM Computer-Aided Design and Manufacturing	3	2	1h30		1h00	22h00	30h00	40%	60%
	Lab Modeling and Diagnosis of Mechatronic Systems	2	1			1h30	22h30	27h30	100%	
	Lab Dynamic Systems Control	2	1			1h30	22h30	27h30	100%	
Transversal UE Code: UET 2.1 Credits: 3 Coefficients: 3	Reserve engineering	2	2	1h30	1h30 workshop		22h30	5h00	40%	60%
	Literature Search and Memory Design	1	1	1h30			22h30	02h30		100%
Semester 3 total		**30**	**17**	**12h00**	**6h00**	**7h30**	**382h30**	**366h30**		

Semester 4

Internship in a company sanctioned by a thesis and a defense.

	VHS	Coeff	Credits
Personal work	550	09	18
Internship in a company	100	04	06
Seminars	50	02	03
Other (Framing)	50	02	03
Total Semester 4	750	17	30

This table is given for information purposes only

Evaluation of the Master's End of Cycle Project

- Scientific value (Jury's assessment) /6
- Writing of the Thesis (Jury's Assessment) /4
- Presentation and answer to questions (Jury's assessment) /4
- Supervisor's assessment /3
- Presentation of the internship report (Jury's assessment) /3

III - Detailed programme by subject of the S1 semester

Semester: 1
Teaching unit: UEF 1.1.1
Material 1: Applied electronics
VHS: 45h00 (Course: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Mastery of electronic circuits in an industrial process – measurement support – conditioning of a signal for interfacing with computer systems.

Recommended prior knowledge:

Industrial computing-fundamental electronics.

Material content:

Chapter 1. : Introduction to Process Control - Measurement Chain - Wheatstone Bridge Circuit. Adaptation of a signal to a measurement chain - Amplification, linearization, conversion, filtering. **(2 weeks)**

Chapter 2. : Analog Signal Conditioning. Introduction - Principle of Analog Signal Conditioning - Passive Circuits. Instrumentation Operational Amplifier - Practical Design Considerations. **(2 weeks)**

Chapter 3. : Digital Signal Conditioning. Introduction–
Digital Fundamental Circuits - A/D and D/A Converters
Data acquisition systems. **(2 weeks)**

Chapter 4. : Control Process: Discrete state. **(2 weeks)**

Chapter 5. : Principle of controller. **(2 weeks)**

Chapter 6. : Controller analog. Electronic controller – pneumatic controller – design principle. **(2 weeks)**

Chapter 7. : Digital controller**.** One-variable system – multi-variable system – networked process control. **(3 weeks)**

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. *P. Lyonnet, M. Thomas, R. Toscano. Signal Conditioning and System Diagnostics, Tec & Doc Lavoisier, 2012.*
2. *D. Jonhison. Industrial Process Control, Theory & Applications, Courses & Exercises, Ellipses, 2011.*
3. *A.P. Malvino, "Principle of Electronics", Ediscience.*
4. *J. Millman. "Microelectronics", Ediscience.*
5. *M. Dubois, "Basic Electronic Components", Université Laval, 2006.*
6. *M. Girard, "Discrete Active Components". Volume 2: Field-effect transistors, Ediscience.*
7. *Ch. Gentili, "Microwave amplifiers and oscillators", Masson.*
8. *F. Milsant , « Problems of electronics, Chihab-Eyrolles, 1994.*

Semester: 1
Teaching unit: UEF 1.1.1
Material 2: Automation
VHS: 45h00 (Course: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Understand the need for automation in industrial processes and know the technologies implemented for automation and master techniques for the automation of industrial processes.

Recommended prior knowledge:

Combinatorial and Sequential Logic, Programming Languages

Material content:

Chapter 1. General information on automated systems and industrial computing (3 weeks)

- Definitions, constituents of an automated system, notions of information chain and chain of action, contributions of automation in industry, control logic technologies, tools for functional analysis of needs
- Automation and structure of automated systems
- Classification of automated systems
- Methods for analyzing the operation of automated systems
- The decisive role of IT in industry
- Specification of specification levels, performance and challenges.

Chapter 2.: Elements of digital electronics for automation (3Weeks)

- Combinatorial system, approach to solving a combinatorial system, sequential system, tools for modeling sequential systems
- Study and drawing of a diagram of some sequential circuits (electronic, electrical and pneumatic), components of a pneumatic installation.

Chapter 3.: Modeling of discrete event systems (3 weeks)

- Types of processus
- Modeling Tools,
- Choice of control technology: wired logic – programmed logic.
- The Grafcet

Chapter 4.: Structured Approach to Automated Systems (3 Weeks)

- Task Concepts and Task Grafcet
- Structuring and coordination of tasks
- Macrosteps, encapsulation
- On/Off Mode Study (GEMMA)

Chapter 5. : Industrial Programmable Logic Controllers (PLCs). (3 weeks)

- Introduction to the Study of Computers,
- Architectural study of microprocessors
- Architectural study of microcontrollers
- Internal structure and description of the elements of an A.P.I
- Choice of a programmable logic controller,

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. *Ronald J. Tocci, Reynald Goulet. Digital Circuits: Theory and Applications. 1996 edition.*
2. *Mouloud Sbai. Combinatorial Logic and Digital Components, Corrected Courses and Exercises, Ellipses Edition, 2013.*

3. *Jean-Yves Fabert. Automatisms and Automation: Corrected Courses and Exercises. Edition Ellipses, 2003.*
4. *René David, Hassan Alla. From Grafcet to Petri Networks. Edition Hermès, 1992.*
5. *Simon Moreno, Edmond Peulot. Le Grafcet: Design-Implementation in Programmable Logic Controllers. Edition Casteilla, 2009.*
6. *G. Michel. APIs: Architecture and applications of programmable logic controllers. Edition Dunod 1988.*
7. *William Bolton. Industrial programmable logic controllers. Edition Dunod 2010.*
8. *Frederic P.Miller, Agnes F.Vandome, John McBrewster.Industrial Programmable Logic Controllers: Computer Programming. Edition Alphascript Publishing 2010.*
9. *Khushdeep Goyal and Deepak Bhandari. Industrial Automation and Robotics. Katson Books. 2008.*
10. *Gérard Boujat and Patrick Anaya. Industrial automatic in 20 sheets. Dunod. 2013.*
11. *Automatism. 3rd ed. Saint-Denis-La Plaine, Afnor, 1991. - XI-157*

Semester: 1
Teaching unit: UEF 1.1.1
Material 3: Mechanical design
VHS: 22h30 (Course: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

To study the techniques for sizing the main technological functions used in the design of mechanical systems. Present an integrated vision of the different technologies to be implemented for the realization of a complex mechanical system. Study geometric modeling techniques in Computer-Aided Design. Learn about Pro/Engineer and Catia V5 industrial CAD software through mini projects

Recommended prior knowledge:

General knowledge of mechanics, RDM, programming

Material content:

Chapter 1. : Introduction to the Design Office. Definition of the specifications - Elements for the choice and sizing of structures and components - Validation of the proposed technical solutions. Detailed definitions of technical solutions (quotation, manufacturing). **(3 weeks)**

Chapter 2.: Study and sizing of mechanical systems. Modelling, mechanism theory, contact theory –Transmission by flexible links and rigid links. **(3Weeks)**

Chapter 3. : Surface contact and rolling element connections
Shrink-fitting, threaded, obstacle, bonding
– Hydrodynamic and hydrostatic guidance
– Fatigue sizing. **(2 weeks)**

Chapter 4. : Complex mechanical systems. Integration of mechatronic mechanisms and systems.
Integration of new technological solutions (mechanical, optical, IT).
Management of complex mechanical system design projects by group.
Case study. **(2 weeks)**

Chapter 5. : Circuit engineering. Circuit design
– application of design tools
– circuit analysis
– Assembly and start-up. **(2 weeks)**

Chapter 6. : Assembly and start-up of a CNC switch.
-Assembly and start-up of a robot system
– assembly and start-up of a mechatronic production switchgear, Testing and troubleshooting. **(2 weeks)**

Evaluation method:

Examination: 100%.

Bibliographical references:

1. *Alain Pouget , ThierryBerthomieu , Yves Boutron, Emmanuel Cuenot, "Structures and mechanisms - Mechanical construction activities", Ed. Hachette Technique.*
2. *R. Quatremer, J-P Trotignon, M. Dejans, H. Lehu, "Précis de Construction Mécanique", Volume 1, Projects-studies, components, standardization, Afnor, Nathan 2001.*
3. *R. Quatremer, J-P Trotignon, M. Dejans, H. Lehu. "Précis de Construction Mécanique", Volume 3, Projects-calculations, sizing, normalization, Afnor, Nathan 1997.*

4. *Youde Xiong, Y. Qian, Z. Xiong, D. Picard. Mechanical Form, Construction Parts, Eyrolles, 2007.*
5. *Jean-Louis Fanchon. "Guide de Mécanique", Nathan, 2008.*
6. *Francis Esnault, "Mechanical Construction, Power Transmission", Volume 1, Principles and Ecodesign, Dunod, 2009.*
7. *Francis Esnault, "Mechanical Construction, Power Transmission", Volume 2, Applications, Dunod, 2001.*
8. *Francis Esnault, "Mechanical Construction, Power Transmission", Volume 3, Power Transmission by Flexible Links, Dunod, 1999.*
9. *Bawin, V. and Delforge, C., "Construction mécanique", Original edition: G. Thomé, Liège, 1986.*
10. *M. Szwarcman, "Eléments de machines", Lavoisier edition 1983*
11. *W. L. Cleghorn, " Mechanics of machines", Oxford University Press, 2008.*

Semester: 1
Teaching unit: UEF 1.1.2
Material 1: Sensors and actuators
VHS: 45h00 (Lecture: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

To know the different elements of a measurement chain: the operating principle of a sensor, the metrological characteristics, the appropriate conditioner.

Recommended prior knowledge:

Electrical measurements, Basic electronics.

Material content:

Chapter 1. : The constituent elements of a measurement chain, the sensors (passive, active), the conditioning circuits (divider, bridges, amps and instrumentation amplifiers). **(1 week)**

Chapter 2. : Temperature sensors. Platinum probe, thermistor, thermocouple. **(2Weeks)**

Chapter 3.: Photoresist, photodiode, phototransistor photometric sensors **(2 weeks)**

Chapter 4.: Position sensors. Resistive, inductive, capacitive, digital, proximity. **(2 weeks)**

Chapter 5. : Deformation sensors. Force and pressure. **(2 weeks)**

Chapter 6.: Rotational speed sensors. Analog, digital tachometer. **(2 weeks)**

Chapter 7. : Flow, level, humidity sensors. **(2 weeks)**

Chapter 8. : Data acquisition chain. **(2 weeks)**

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. *Georges Asch and Collaborators. Sensors in industrial instrumentation, (Dunod 1998)*
2. *Ian R. Sintclair. Sensors and transducers, Newnes, 2001.*
3. *J. G. Webster. Measurement, Instrumentation and Sensors Handbook, Taylor & Francis Ltd.*
4. *M. Grout. Industrial Instrumentation: Specification and Installation of Sensors and Control Valves, Dunod, 2002.*
5. *R. Palas-Areny, J. G. Webster. Sensors and signal conditioning, Wiley and Sons, 1991.*
6. *R. Sinclair. Sensors and Transducers, Newness, Oxford, 2001.*
7. *J. P. Bentley, "Principles of measurement systems", Pearson education 2005.*
8. *Yves Granjon, "Automatique - Linear systems, nonlinear systems, continuous time, discrete time, state representation", Dunod, 2010.*
9. *P. MAYE, "Electric Motors for Robotics", Dunod Paris 2000.*

Semester: 1
Teaching unit: UEF 1.1.2
Subject 2: Signal processing
VHS: 45h00 (course: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

At the end of the course, the student should master the following concepts: the analysis of signals and systems (continuous, discrete, deterministic, random) as well as the digitization of the signal

Recommended prior knowledge:

Linear Algebra, Fourier Series, Matlab/Simulink Use

Material content:

Chapter 1. : General. Transmission of Information - Classification of Signals (Deterministic Signals, Random Signals). **(2 weeks)**

Chapter 2.: Energy and Power of Signals. Power and Energy of a Signal-Crossed Power and Energy of Two Signals-
Notion of signal-to-noise ratio. . **(1 week)**

Chapter 3.: Convolution and deconvolution. Definitions and Properties-Applications **(1 week)**

Chapter 4.: Correlation and Intercorrelation. Autocorrelation and Intercorrelation Functions - Relationship Between Correlation and convolution-applications. **(1 week)**

Chapter 5.: Modeling of deterministic signals. Fourrier series and integral
- Spectral density of deterministic signals
- Laplace transform and Z transform
- Introduction to wavelet analysis
-Transfer function – Filtering. **(2 weeks)**

Chapter 6. : Digital signals. Sampling: Dirac pulses. Shannon's theorem - Discrete Fourrier transform - Spectral analysis. Cepstre -Numerical Filtering -Time-Frequency Analysis. **(2 weeks)**

Chapter 7. : Hilbert's conversion. Definitions and properties
-Analytical signal -Envelope detection. **(2 weeks)**

Chapter 8. : Random signals. Notions of random function -Characterization of stationary random functions -The main random functions. **(2 weeks)**

Chapter 8. : Wavelet analysis. **(2 weeks)**

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1 *Martin, Jean-Noël Débuter en traitement numérique du signal: signals et systèmes: applications au filtration et au traitement des sons: cours et exercices résolus Paris: Ellipses, 2005*
2 *Destuynder, PhilippeSanti, Françoise Scientific Computing: Analysis and Numerical Control of the Signal Paris: Ellipses, 2003*
3 *Jacques Lacoume, Jean-Louis Max, Methods and techniques of signal processing, 5th ed. Paris: Dunod, 2000*
4 *Tanguy, Jean-Pierre, Theory and Practice of the Signal: Deterministic and Random Signals in Continuous and Discrete Paris: Ellipses, 2007*
5 *Benidir, Messaoud , Theory and processing of signal. 1, Representation of signals and systems: corrected courses and exercises Paris: Dunod, 2002*

6 *Neffati, Tahar, Traitement du signal analogue: cours Paris: Ellipses, 1999*
7 *Van den Enden, Ad W.M.Digital signal processing. Paris: Masson, 1992*
8 *Neffati, Tahar , Exercises and solved problems of analog signal processing electrical engineering. Paris: Ellipses, 2004*

Semester: 1
Teaching Unit: UEM 1.1
Subject 1 : Practical work Signal processing
VHS: 22h30 pm (TP: 1h30)
Credits: 2
Coefficient: 1

Material content:

Lab 1: signals, operations on sinusoidal signals at (frequency; amplitude; and phase shift) different. **(3 hours/student)**
Lab 2: Fourier series: approximation of a given periodic signal in Fourier space/basis with a sufficient number of harmonics. (Manual calculation of the coefficients, then simulation: the corresponding graph must be confused with the signal given at the logical level; as well as at the precision). **(4.5 hours/student)**
Lab 3: Filtering. Simulation of a signal disturbed by additive noise, design/insertion of the appropriate filter (depending on the useful frequencies and noise), the signal after filtering must be confused with the useful signal **(4.5 hours/student)**
Lab 4: Filtering, Application: signal Speech noisy by a high frequency: acquisition and processing **(3 hours/student)**
Lab 7: Hilbert-Transform: Envelope Detection **(3 hours/student)**

Evaluation method:

Continuous assessment: 100 %.

Bibliographical references:

Course notes and methodical overviews of the laboratory.

Semester: 1
Teaching unit: UEM 1.1
Subject 2: Applied Electronics Lab
VHS: 22h30 (WP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives

Discover the constitution of a measurement chain, identification of the different parts. Application of Operational Amplifier in Industry

Recommended Prior Knowledge

Fundamental electronics, sensors.

Material content

Lab 1 : Balancing a Wheatstone bridge
Lab 2: Operational amplifier assembly – inverter, summer, differentiator.
Lab 3: Operational amplifier assembly – derivator, integrator, exponentiation and logarithm assembly
Lab 4: Comparator assembly (applications)
Lab 5: A/D and D/A converter

Evaluation method

Continuous assessment: 100%.

References

Course notes: electronics, combinatorial and sequential logic, electrical machines, methodical overviews of the laboratory.

Semester: 1
Teaching Unit: UEM 1.1
Subject 3: Automation practical work
VHS: 22h30 pm (WP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

Discover the different constituent bodies an automatism. Power Organ and Control Device.

Recommended prior knowledge:

Sensors, hydraulics and pneumatics.

Material content:

Lab 1: Controlling a DC motor.
Lab 2: Automatic operation
Lab 3: Intervention walk
Lab 4: Pneumatic Techniques (Applications)
Lab 5: PLC control (application: sorting system, elevator, trolley).

Evaluation method:

Continuous assessment: 100 %.

Bibliographical references:

Course notes: electronics, combinatorial and sequential logic, electrical machines, methodical overviews of the laboratory.

Semester: 1
Teaching Unit: UEM 1.1
Subject 4: Practical work Mechanical design
VHS: 22h30 (WP: 1h30)
Credits: 2
Coefficient: 1

Material content:

Lab 1: Simulation: Sizing a mechanical system
Lab 2: Simulation: Transmission by flexible links and rigid links.
Lab 3: Programming of surface contact connections and interposition of rolling elements
Lab 4: Simulation of the start-up of a robot system
Lab 5: Simulation and start-up of a mechatronic production apparatus

Evaluation method:

Continuous assessment: 100 %.

Bibliographical references:

Notes from the lectures, methodical overviews of the laboratory.

Semester: 1
Teaching Unit: UEM 1.1
Subject5 : Practical work Sensors and actuators
VHS: 22h30 (WP: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Perform manipulations to enrich knowledge about sensors and their calibration.

Recommended prior knowledge:

Electrical and electronic measurements.

Material content:

Lab 1: Photometric sensors.
Lab 2: Deformation and force sensors.
Lab 3: Position sensors (capacitive and inductive).
Lab 4: Temperature sensors.
Lab 5: Rotational speed sensors.
Lab 6: Piezoelectric vibration sensors.

Evaluation method:

Continuous assessment: 100 %.

Bibliographical references:

Notes from the course on sensors and conditioners, methodical overviews of the laboratory.

Semester: 1
Teaching unit: UET 1.1
Subject: Advanced Python programming
VHS: 45h00 (Course: 1h30, WP)
Credits: 2
Coefficient: 2

Teaching objectives:

Targeted skills:

- Use of computer tools for the acquisition, processing, production and diffusion of information.
- Skills in Python and project management,
- Skills in automation and data visualization.

Objectives:

- Deepen students' mastery of the Python programming language and introduce them to the fundamentals of data analysis and artificial intelligence.
- Acquire a solid foundation in computer science.
- Learn to program in Python and Excel.
- Master task automation.
- Master project management software.

Materials needed:

- A computer with Python installed,
- Python libraries: NumPy, Pandas, Scikit-learn, Matplotlib, os.listdir, os.path.exists, os.mkdir, os.rmdir, Matplotlib, Seaborn, Plitly, Request, Beautiful Soup, Tkinter, PyQT,
- Tensorflow, PyTorch, etc.

Recommended prior knowledge: Python programming

Material content:

Chapter 1: Python Programming Review (2 Weeks)

1. Introduction: Basic computer science concepts and digital tools, installing Python.
2. Introduction to the concept of an operating system: Roles, types (Linux, Windows, etc.), priority management.
3. Introduction to computer networks (Principles, IP address, DNS, internet, etc.).
4. Basic programming: Interactive and script modes, variables, data types, operators. Conditional structures and loops (if, for, while).
5. Essential functions and elements: Predefined functions and function creation. Standard modules (math, random). Strings, lists, basic database manipulation.
6. Files, Lists, Tuples, Dictionaries
7. Exercises:
   - Python learning exercises
   - Exercises using the libraries covered in the course (Math, Random, NumPy, Pandas, etc.)

Chapter 2: Programming and Automation (4 weeks)

1. Principles of Task Automation
   - Python libraries for automation:
     - ✓ Pandas and NumPy.
     - ✓ Os, shutil: file and folder manipulation
     - ✓ Openpyxl or pandas: working with Excel or CSV files
   - Definitions and automation examples (sending emails, etc.)
2. File Manipulation with Python:
   - Using libraries to:
   - ✓ Browse a folder (os.listdir)

- ✓ Check for the existence of a file or folder (os.path.exists)
- ✓ Create or delete folders (os.mkdir, os.rmdir)
- ✓ Visualize data: Matplotlib, Seaborn, Plitly
- ✓ Request to interact with Application Programming Interfaces (APIs)
- ✓ Beautiful Soup for data scraping
- ✓ Tkinter, PyQt for visualizing graphical data
- Copy or move files with shutil…
- Search, sort, and generate simple reports.
- Serialization and deserialization (using the pickle module).
- Serialization of objects and processing of large files (streaming).

3. Exercises:

- Using openpyxl and pandas to read, modify, and write Excel or CSV files to:
  - ✓ Create automatic reports
  - ✓ Automatically extract data
  - ✓ …
- Writing scripts to:
  - ✓ Process text files (searching, sorting)
  - ✓ Automate technical calculations
  - ✓ Manage simple reports (PDF, Excel)
  - ✓ …
- Sorting, searching, and insertion sort algorithms
- Implementing a search function in a list.
- File operations
- Secure browsing (configuring simple networks, managing passwords)

Chapter 3: Advanced Excel Learning **(2 weeks)**

1. Macro Principles and Creating a Simple Macro,
2. Pivot Tables,
3. Column Charts,
4. Bar Charts,
5. Spider Chart,
6. Etc.
7. Excel Exercises…

Chapter 4: Learning GanttProject **(2 weeks)**

1. Introduction to Project Management:
   - What is a project?
   - What are the challenges of project management?
   - GanttProject Interface
2. Tasks (creation, modification, organization)
3. Time Management (project start and end dates)
4. Resource Management
5. **Exercises** on GanttProject

Chapter 5: Advanced Object-Oriented Programming **(3 weeks)**

1. Code Organization:
   - Custom functions, parameters, return values.
   - Modules, imports, and packages.
2. Complex Data Structures:
   - Lists, tuples, and dictionaries: creation, modification, deletion, traversal.
3. Fundamental Concepts of Object-Oriented Programming (OOP):

- Classes, objects, attributes, and methods.
- Public, private, and protected attributes.

4. Special Methods:
   - init, str, repr, len.
5. Advanced Concepts:
   - Encapsulation, abstraction, inheritance, polymorphism.
   - Advanced inheritance, decorators, design patterns, metaclasses.

6. Exercises

Chapter 6: Introduction to Data for AI **(2 weeks)**

1. Introduction to Common AI Datasets:
   - Iris, MNIST, CIFAR-10, Boston Housing, ImageNet.
2. Data Preprocessing for Machine Learning:
   - Data Cleaning, Normalization, Encoding, and Separation.
   - Cross-validation.
3. Feature Engineering Techniques:
   - Feature Selection and Creation, and Dimensionality Reduction.
4. Essential Libraries for Developing AI Models:
   - scikit-learn, TensorFlow, Keras, PyTorch
5. Exercises

Practical Exercises:

Lab 1: Mastering the Basics of Python Programming
(Control Structures, Types, Loops, Simple Functions)

1. Introduction
2. Reading and Processing Text Files
3. Managing Simple Reports (PDF, Excel)

Lab 2:

- Develop specifications for a mini-project automating tasks with Python, consisting of automatically identifying and sending reports by email:

1. Load data from a file (e.g., experimental measurements),
2. Perform simple statistical calculations on the data (mean, standard deviation with interpretation),
3. Generate a graph,
4. Send the results using Python.

Lab 3:

1. Programming the Excel dashboard seen in the tutorial
2. Creating automated Excel spreadsheets
3. Simple macros
4. Conditional formulas
5. Research

Lab 4:

Organizing a meeting using a Gantt chart

1. Create a new project:
   - Project name: "Meeting…"
   - Start date: Date and time of the meeting
   - Estimated duration: Total duration of the meeting
2. Defining tasks:
   - Agenda items (each agenda item becomes a task)
   - Subtasks: If an item is multi-item, create the corresponding subtasks
   - Initial and final tasks (e.g., "Welcoming participants," "Closing the meeting")

3. Defining resources:
   - Participants (each participant is a resource)
   - Equipment (computer, projector, etc.)
4. Estimating durations:
   - Duration Time required for each agenda item
   - Transition time from one item to the next
5. Creating the Gantt chart:
   - Visualize the agenda
   - Identify key items
6. Track progress in real time (projection of the Gantt chart)

Lab 5: Advanced Structures and Code Organization
(Custom functions, dictionaries, modules, and modular organization)

Lab 6: Advanced Object-Oriented Programming in Python

(Encapsulation, inheritance, special methods, simple design patterns)

Lab 7: File Manipulation and Data Analysis

(Reading/writing files, text processing, introduction to Pandas and NumPy)

Lab 8: Data Preparation and Processing for Artificial Intelligence

(Loading AI datasets, cleaning, transformation, feature selection)

Final Project
Title: Analysis and Visualization of a Dataset + Simple Predictive Model
Skills Used: Data reading, OOP, advanced structures, Pandas, Scikit-learn. (Oral presentation + written report).

Evaluation method:

Exam: 60%, Continuous assessment: 40 %.

References:

[1] . E.Schultz et M.Bussonnier (2020) : Python for SHS. Introduction to Data Programming. University Press of Rennes.

[2] . C.Paroissin, (2021) : Practical application of data science with R: arranging, visualizing, analyzing and presenting data. Paris : Ellipses, DL 2021.

[3] . S.Balech et C.Benavent : NLP texte minig V4.0, (Paris Dauphine – 12/2019) : link : https://www.researchgate.net/publication/337744581_NLP_text_mining_V40_-_une_introduction_-_cours_programme_doctoral

[4] . Allen B. Downey Think Python: How to Think Like a Computer Scientist, O'Reilly Media, 2015;

[5] . Ramalho, L.. Fluent Python. " O'Reilly Media, Inc.", 2022;

[6] . Swinnen, G.. Learn to program with Python 3. Editions Eyrolles, 2012;

[7] . Matthes, E. Python crash course: A hands-on, project-based introduction to programming. no starch press, 2019

[8] . Cyrille, H. (2018). Learn to program with Python 3. Eyrolles, 6ème édition. ISBN: 978-2212675214

[9] . Daniel, I. (2024). Learning to code in Python, I read

[10] . Nicolas, B. (2024). Python, from complete beginner to object-oriented programming: Course and solved exercises, 3rd édition, Ellipses

[11] . Ludivine, C. (2024). Selenium: Master your functional tests with Python, Eni

Ressources en ligne :

- Official documentation Python : docs.python.org
- Python exercises on Codecademy: codecademy.com/learn/learn-python-3
- W3Schools Python Tutorial : w3schools.com/python/

III - Detailed programme by subject of the S2 semester

Semester: 2
Teaching unit: UEF 1.2.1
Subject 1: Robotics and control
VHS: 45h00 (Course: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

To be able to model a simple mechanism in a system of rigid non-deformable solid bodies, to be able to solve the associated static, kinematics and dynamics problems.

Recommended prior knowledge:

Basic knowledge of solid mechanics, kinetics and dynamics of rigid bodies, theory of mechanisms and torsors, and mathematics

Material content:

Chapter I: Introduction to Robotics **(1 week)**
(Definitions, Terminology, Types of architectures: Serial robots, Parallel robots, mobile robots, flexible robots, walking robots etc.)
Chapter II: Parameterization of a solid and a chain of solids in space **(2 weeks)**
Chapter III: Direct and inverse geometric models **(3 weeks)**
Chapter IV: Direct and inverse kinematic models **(2 weeks)**
Chapter V: Dynamic Modeling (Lagrange Formalism, Formalism of Newton-Euler) **(3 weeks)**
Chapter VI: Motion Generation **(2 weeks)**
Chapter VII: Study of the control of a robot in space articular **(2 weeks)**

Mini-project: Modeling a robot for a precise task, determination of the workspace and optimal placement of a robot. **(Work from home)**

Method of evaluation:

Continuous assessment: 40%, examination: 60%.

References:

1. *Modeling, identification and control of robots, Wisama Khalil and Etienne Dombre; Herrmes, Lavoisier, 1999.*
2. *Theory of Perfect Mechanisms: Design Tools Author(s): leroy Lavoisier 1998*
3. *Simplified Theory of Elementary Mechanisms Author: Loche L.-E. Dunod 2001*
4. *J. P. Lellmend and Said Zeghloul, " Robotics, fundamental aspects, Masson, **1991.***
5. *Theory of Perfect Mechanisms: Design Tools Author(s): leroy Lavoisier 1998*
6. *A. Pruski, General robotics. Ellipses **1988***
7. *P. André Traité de robotique T4: Constituants technologiques. Hermès **1986***
8. *M. Cazin and J. Metje, Mécanique de la robotique, Dunod**, 1989***
9. *Jack Guittet Medical robotics. Hermès **1998***

Semester: 2
Teaching unit: UEF 1.2.1
Subject 2: Diagnosis by vibration analysis
VHS:45h00 (Course: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Acquisition of basic knowledge on the effects of mass, inertia and deformations on movements to make a good diagnosis.

Recommended prior knowledge:

Basic knowledge of Mathematics

Material content:

Chapter 1 Vibration of Structures: (3 weeks)
General information on vibrations, recall of one-dl systems, analytical study (free and forced), two-dl systems, analytical study (free and forced), definition of an oscillator, definition of a periodic motion, complex representation, characteristics, superposition of vibratory motion, characteristics.
Chapter 2 Study of the main defects: (4 weeks)
Introduction to vibration diagnosis, main defects: imbalance defect: definition, measurement, vibration signature and spectral analysis; Misalignment: definition, misalignment of coupled shafts, radial, angular and bearing misalignment and spectral analysis of signatures. Tightening faults, belt transmission faults, bearing faults and gear faults.
Chapter 3 Electromagnetic Waves: (4 weeks)
Definition, physical and mathematical representation, behavioural studies, acoustic metrology, areas of use. Ultrasonic Measurements in Fluids... etc. areas of use.
Chapter 4 Diagnosis and Fault Source Localization (2 weeks)
Diagnosis and location of the source of failures, spectral analysis of cases.

Method of evaluation:

Continuous assessment: 40%, examination: 60%.

Bibliographical references:

1. *The Dynamics of Systems, Daniel Thiel Publisher: Hermès Science Publications*
2. *Introduction to System Dynamics (Paperback)*
3. *Javier Aracil (Author) Publisher: Presses Universitaires de Lyon (PUL)*
4. *Dynamics of structures Patrick Paultre Hermès - Lavoisier*
5. *Dynamics of structures, CLOUGH RAY WILLIAM, Published by pluralis.*
6. *Dynamics of structures: Digital modal analysis by Thomas Gmür Publisher: Presses Polytechniques et Universitaires Romandes. (1966).*
7. *Charbi, Radouane. Analysis of vibration phenomena in rotor dynamics, modelling and experimentation. University of Batna : s.n., 2014 .*
8. *Miche, l Lalanne and Cuy, Ferraris. dynamics of the rotors in bending. Paris : Technique de l‟ingénieur , 1996.*

Semester: 2
Teaching unit: UEF 1.2.1
Topic 3: Non-Destructive Testing and Evaluation
VHS: 22h30 pm (Lecture: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

Introduce the student to non-destructive testing and technical inspection of on-board networks (vehicles).

Recommended prior knowledge:

Physics, Mechanics, Signal Processing

Material content:

Chapter 1. : Introduction to non-destructive testing, interest, principle and classification of defects to be checked (internal, external, etc.), chronological classification of control methods, classifications by efficiency **(1 Week)**

Chapter 2.: Classical Methods: X-ray, Ultrasound, Penetrant Testing, Magnetic Particle Testing: Eddy Currents...: Principle and Schematic Diagram and Areas of Operation. **(2Weeks)**

Chapter 3.: X-rays: tomography, digital radio: principle and fields of use **(2Weeks)**

Chapter 4.: Ultrasound: multi-element, imaging, TOFD, guided waves... **(2Weeks)**

Chapter 5.: Thermography: principle, mathematical model, method of resolution and frequency analysis (**2Weeks)**

Chapter 6.: Acoustic emission: mathematical model, resolution method and frequency analysis (**2Weeks)**

Chapter 7. : Tools technical control of on-board mechatronic systems, scanners, Application spectral analysis **(2 weeks)**

Evaluation method:

Review: 100%.

Bibliographical references:

1. *B. Chalmond et al., "Diagnosis and Evaluation of Production Systems: Non-Destructive Testing", Cachan 1999, revised 2003*
2. *Surkus E and Portaux R [2010] Thermography, Professional Degree in Production Management Industrial University Lille*
3. *Gaussorgues G [1999] Engineering techniques: Report on Radiometry and Infrared Thermography, 4th Tech & doc Ed*
4. *Rahmoun Moncef Design and installation of a station for the x-ray control of materials. UNIV: BATNA 2 CUB 2015.*
5. *Taleb M'hammed Mustapha and Ghedamsi El Hachmi. Semi-analytical modeling of a C-NDT system. F master 2013.*

Semester: 2
Teaching unit: UEF 1.2.2
Subject 1: Architecture and programming of programmable logic controllers
VHS: 45h00 (course 1h30, tutorial 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Master and design automated systems. To be able to intervene in the systems as part of maintenance.

Recommended prior knowledge:

Hydraulic and pneumatic technology – logic system.

Material content:

Chapter 1. : Study of the general structure of an automatic system.
Operational part - Control part: logical processing of information - Actuators - Relationship or interface part. **(2 weeks)**

Chapter 2. : Sequential logic. Direct synthesis of an automation - Process of studying an automation - Choice of a control technology: wired logic – programmed logic. **(2 weeks)**

Chapter 3. : Ladder, Boolean, Grafcet programming. Description of an automated system, grafcet model, simplification of a graphic design of a grafcet. **(2 weeks)**

Chapter 4. : Program logic. **(2 weeks)**

Chapter 5. : The Gemma. Basic designs, presentation of the graphic guide, method of implementation. **(2 weeks)**

Chapter 6. Introduction to API. Programmed Logic and Domain of Use – Structure Sequencer in APIs. **(3 weeks)**

Chapter 7. : Industrial Applications. **(2 weeks)**

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. Automation Foundations and applications, exercises and solved problems.
2. José-Philippe Pérez, Christophe Lagoute, Jean-Yves Fourniols, Stéphane Bouhours Collection, Dunod 2014.
3. The APIs and their applications Corrected Courses and Exercises Level A, Ellipses Marketing, 2015.
4. Karnos E, Architecture of programmable automatons, course with solved exercises, Masson 2016.

Semester: 2
Teaching unit: UEF 1.2.2
Subject 2: Industrial Computing
VHS: 45h00 (Lecture: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

- Acquisition of basic knowledge in industrial computing,
- Design and programming of computerized systems for industrial use

Recommended prior knowledge:

Electronics, mathematics

Material content:

Chapter 1. : Knowledge of the different types of instruction, Industrial applications. **(1 week)**

Chapter 2. : Concept of interruption, **(1 week)**

Chapter 3. Programming in Assembler. **(2 weeks)**

Chapter 4. : Programming in C & Microcontroller Language **(2 weeks)**

Chapter 5. : Applications: PLCs, robotics, Physical quantity measurements, Real-time systems, Embedded system design: hardware development, software development, testing **(4 weeks)**

Chapter 6. : Digital data acquisition and processing - Real-Time, Interruption Management, **(2 weeks)**

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. *Eric Magarotto, "Industrial Computer Science Course", Academic Year 2005-2006*
2. *Tichon J., Couwenbergh C., Giot R. and Garcia Acevedo S. Communication with peripherals. Techniques de l'Ingénieur, traité Informatique Industrielle, 2002*
3. *Digital Image Acquisition and Processing, Paul Sabatier University, IUT - Department of Physical Measurements, J.P. Gastellu-Etchegorry. April (2008).*

Semester: 2
Teaching unit: UEM 1.2
Subject 1: Software workshop and advanced programming
VHS: 45h00 (course 1h30, WP: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives:

The objective of this module is to carry out a mini project of a mechatronic system based on a summary expression of need. The theme of this project is maintained throughout the training in the mechatronics sector. At the end of this module, the detailed specifications are drafted, and the architecture of the system is defined.

Recommended prior knowledge:

Mechanical design – theory of mechanisms and systems – applied computer engineering – mechatronic systems.

Material content:

Mathematical simulation: Maple, Mathematica, Matlab, Scilab, Octave.....	**(2 weeks)**
Numerical simulation: Calculation, Visualization, ...	**(2 weeks)**
Graphical programming	**(2 weeks)**
Image Visualization	**(2 weeks)**
Signal analysis: LabVIEW, Matlab, Scilab, simulink	**(2 weeks)**
3D geometry workshop.	**(2 weeks)**
Abaqus	**(2 weeks)**

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

Books and handouts, websites, etc.

Semester: 2
Teaching unit: UEM 1.2
Subject 2: Diagnostic work by vibration analysis
VHS: 22h30 (WP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

- Application of the theoretical knowledge acquired on the effects of vibrations and their use in diagnostics

Recommended prior knowledge:

Basic knowledge of Mathematics

Material content:

Lab 1: Numerical testing of vibration subsystems and exploitation of measurement by frequency analysis
Lab 2: Vibration measurement on rotating systems
Lab 3: Acquisition and exploitation of acoustic waves from mechatronic systems
Lab 4 : Inspection of installations by acoustic emission

Evaluation method:

Continuous assessment: 100 %.

Bibliographical references:

1. *Adrian Biran, Moshe Breiner, "MATLAB for Engineer Version 6 and 7" PEARSON Edition, Education, August 2004*
2. *M.Mokhtari, M.Marie, "Applications of MATLAB 5 Simulink 2", Springer Edition, 1998.*
3. *Eric FERRET - Cyril IACONELLI, "Use of Comsol Multiphysics in the realization of numerical models" 06/12/2011*

Semester: 2
Teaching unit: UEM 1.2
Subject 3: Practical work Non-destructive testing and evaluation
VHS: 22h30 (WP: 1h30)
Credits: 2
Coefficient : 1

Teaching objectives:

- Introduce the student to non-destructive testing and technical inspection of on-board systems (vehicles).

Recommended prior knowledge:

Physics, Mechanics, Signal Processing

Material content:

Lab 1: Manipulations**:** Ultrasonic generator, Set of ultrasonic probes, digital oscilloscopes.

Lab 2: Manipulations**:** Standard shims.

Lab 3: Mechanical characterization of materials and defect detection

Lab 4: Eddy Current Generator, Set of CF probes, gauge blocks.

Lab 5: Vibration measurement on rotating systems

Lab 6: Characterization of materials and defect detection.

Evaluation method:

Continuous assessment: 100 %.

Bibliographical references:

Course Notes and Methodical Lab Overviews

Semester: 2
Teaching unit: UEM1.2
Subject 4 : Practical work Architecture and Programming of Industrial Programmable Logic Controllers
VHS: 22h30 pm (WP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

Master and design automated systems. To be able to intervene in the systems as part of maintenance.

Recommended prior knowledge:

Hydraulic and pneumatic technology – logic system.

Material content:

Lab 1: Programming a solution of a combinatorial problem in a textual language (LIST)
Lab 2: Programming a solution to a sequential problem using a textual language (LIST)
Lab 3: Control of a distribution station using a graphic language (LADDER).
Lab 4: Ordering a sorting station in a graphical language (LADDER and SFC).
Lab 5: Programming of counting and timing functions in different languages (LADDER, LIST, and SFC).
Lab 6: Separate programming – LADDER, LIST, LOG or GRAFCET. Interconnection of stations.

Evaluation method:

Continuous assessment: 100 %.

Bibliographical references:

Course Notes and Methodical Lab Overviews

Semester: 2
Teaching unit: UET 1.2.1
Subject 4 : Elements of applied artificial intelligence
VHS: 45h00 (course 1h30, Lab: 1h30)
Credits: 2
Coefficient: 2

Skills targeted:

- Identify the opportunities of artificial intelligence in engineering sciences
- Understand the ethical implications of AI and best practices for its use.
- Ability to use AI techniques in problem-solving

Teaching objectives:

- Mastery of AI algorithms
- Introduction to the fundamental concepts, tools, and applications of modern artificial intelligence, with an emphasis on practical application using Python and its libraries.
- Deepen knowledge of the Python language,
- Understand approaches to AI in problem-solving.

Recommended prior knowledge:

Advanced Python programming

Required materials:

- A computer with Python installed,
- Python libraries: NumPy, Pandas, Scikit-learn, Matplotlib, os.listdir, os.path.exists, os.mkdir, os.rmdir, Matplotlib, Seaborn, Plitly, Request, Beautiful Soup, Tkinter, PyQT, …
- TensorFlow, PyTorch, …
- Course content:

Content of the material:

Chapter 1: Introduction to Artificial Intelligence (AI) **(1 week)**

1. Definitions and applications of AI.
2. Historical evolution of AI.
3. Introduction to major areas:
   - Machine Learning
   - Deep Learning

Chapter 2: Basic Mathematics for AI **(1 Week)**

1. Linear Algebra: Vectors, Matrices, Products, Norms

2. **Probability & Statistics**:
   - Variables, Expected Value, Variance
   - Common Distributions: Normal, Binomial, Uniform

3. Simple Linear Regression:
- Formulation, Cost, Optimization
- Implementation with Scikit-learn

4. Exercises:
- Matrix Manipulation with the NumPy Library (Python)
- Exercise on Linear Regression (using a Python library such as Scikit-learn)
- Explaining the Matplotlib Library (Python)

Chapter 5: Unsupervised Learning

1. Concept of clustering.
2. Algorithms:

- K-means
- DBSCAN (Density-Based Spatial Clustering of Applications with Noise)

3. 2D visualization and interpretation of results.
4. Exercises:
   - Explain how to use a clustering algorithm on a dataset.
   - Explain how to visualize clusters.

Chapter 6: Neural Networks

1. Architecture of a neural network:
   - Perception,
   - Layers and cache layers, weights, biases.
   - Activation functions: ReLU, Sigmoid, Softmax, …
   - Application exercises
2. Introduction to Deep Learning:
   - Concept of deep layers.
   - Introduction to Convolutional Networks (CNNs)
3. **Exercises:**
   - Explain TensorFlow and PyTorch
   - Analyze a text dataset and predict sentiment

Chapter 7: Introduction to Neural Networks

Chapter 8: **Mini-Project** (supervised independent work outside of class):
Creation of a complete classification or clustering model, including preprocessing, training, and visualization; choose and complete one project from start to finish (to be distributed at the beginning of the semester):

- Handwriting recognition
- Natural disaster prediction
- Develop a chatbot capable of answering frequently asked questions from a company in a natural way.
- Develop a system capable of distinguishing normal machine sounds from those indicating an anomaly (defective bearing, excessive vibration, etc.)
- Develop a system (mini AI) capable of analyzing the sentiments expressed in social media posts about a product, brand, or event.

Practical exercises:

Lab 1: Initialization
Lab 2:
• Implement a simple regression using Scikit-learn and visualize it with Matplotlib (for example)
• Visualize the results with Matplotlib
• …
Lab 3:
• Machine learning pipeline and data separation
• Deepen understanding of the concepts covered in the lecture
Lab 4:
• Using Scikit-learn to train a simple classification model
• …….
Lab 5:
• Implement a clustering algorithm on a dataset
• Visualize the clusters: Unsupervised clustering (K-means, DBSCAN)
• ….
Lab 6:
• Build a simple neural network using TensorFlow, PyTorch, or Keras

• Build a simple CNN to classify images (example: MINIST dataset)

Method of evaluation:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

- Ganascia, J.Gabriel (2024) : AI explained to humans. Paris France- Edition le Seuil.
- Anglais, Lise, Dilhac, Antione, Dratwa, Jim et al. (2023) : Ethics at the heart of AI. Quebec Obvia.
- J.Robert (2024) : Natural Language Processing (NLP): definition and principles – Data sciences. Link : https://datascientest.com/introduction-au-nlp-natural-language-processing
- What is natural language processing?. Link : https://aws.amazon.com/fr/what-is/nlp/
- M.Journe : Elements of Discrete Mathematics – Ellipses
- F.Challet : Deep learning with Python – Eyrolles
- H.Bersini (2024) : Artificial intelligence in practice with Python – Eyrolles
- B.Prieur (2024) : Natural language processing with Python – Eyrolles
- V.Mathivet (2024) : Implementation in Python using Scikit-learn – Eyrolles
- G.Dubertret (2023) : Introduction to cryptography with Python – Eyrolles
- S.Chazallet (2023) : Python 3 – The fundamentals of language - Eyrolles
- H.Belhadef, I.Djemal :TALNMethod –Course of Msila University - Algeria

Semester: 2
Teaching unit: UET 1.2
Subject: Compliance with the standards and rules of ethics and integrity.
VHS: 22h30 (Lecture: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:

To develop students' awareness of the respect of ethical principles and the rules that govern life at the university and in the world of work. Raise awareness of respect for and appreciation of intellectual property. Explain to them the risks of moral ills such as corruption and how to combat them, alert them to the ethical issues raised by new technologies and sustainable development.

Recommended prior knowledge:

Ethics and deontology (the basics)

Content of the Materials :

A.Respect for the rules of ethics and integrity,

1. **Reminder of the MESRS Charter of Ethics and Professional Conduct:** Integrity and Honesty. Academic freedom. Mutual respect. Requirement of scientific truth, Objectivity and critical spirit. Equity. Rights and obligations of the student, teacher, administrative and technical staff,

2. Honest and responsible research

- Respect for the principles of ethics in teaching and research
- Responsibilities in teamwork: Professional equality of treatment. Conduct against discrimination. The search for the general interest. Inappropriate conduct in the context of collective work
- Adopting responsible conduct and combating abuses: Adopting responsible conduct in research. Scientific fraud. Conduct against fraud. Plagiarism (definition of plagiarism, different forms of plagiarism, procedures to avoid unintentional plagiarism, plagiarism detection, sanctions against plagiarists, etc.). Falsification and fabrication of data.

3. Ethics and deontology in the world of work:

Legal confidentiality in business. Loyalty to the company. Corporate Accountability, Conflicts of Interest. Integrity (corruption in the workplace, its forms, consequences, methods of combating and sanctioning corruption)

B- Intellectual property

I- Fundamentals of intellectual property

1- Industrial property. Literary and artistic property.
2- Rules for citing references (books, scientific articles, communications in a congress, theses, dissertations, etc.)

II- Copyright

1. Copyright in the digital environment

Introduction. Copyright of databases, copyright of software. Specific case of free software.

2. Copyright in the Internet and Electronic Commerce

Domain name law. Intellectual property on the internet. E-commerce Site Law. Intellectual Property and Social Media.

3. Patent

Definition. Rights in a patent. Usefulness of a patent. Patentability . Patent application in Algeria and around the world.

III- Protection and enhancement of intellectual property

How to protect intellectual property. Violation of rights and legal tool. Valuation of intellectual property. Protection of intellectual property in Algeria.

C. Ethics, sustainable development and new technologies

Link between ethics and sustainable development, energy saving, bioethics and new technologies (artificial intelligence, scientific progress, human rights, human rights, human rights,

Method of evaluation:

Review: 100%

Bibliographical references:

1. Charter of University Ethics and Professional Conduct, https://www.mesrs.dz/documents/12221/26200/Charte+fran ais+d f.pdf/50d6de61-aabd-4829-84b3-8302b790bdce
2. Orders No. 933 of 28 July 2016 laying down the rules relating to the prevention and fight against plagiarism
3. The ABCs of Copyright, United Nations Educational, Scientific and Cultural Organization (UNESCO)
4. E. Prairat, De la déontologie enseignante. Paris, PUF, 2009.
5. Racine L., Legault G. A., Bégin, L., Éthique et ingénierie, Montréal, McGraw Hill, 1991.
6. Siroux, D., Déontologie: Dictionnaire d'éthique et de philosophie morale, Paris, Quadrige, 2004, p. 474-477.
7. Medina Y., La déontologie, ce qui va changer dans l'entreprise, éditions d'Organisation, 2003.
8. Didier Ch., Penser l'éthique des ingénieurs, Presses Universitaires de France, 2008.
9. Gavarini L. and Ottavi D., Editorial. Professional Ethics in Training and Research, Research and Training, 52 | 2006, 5-11.
10. Caré C., Morale, éthique, déontologie. Administration and Education, 2nd Quarter 2002, No. 94.
11. Jacquet-Francillon, François. Concept: professional ethics. Le télémaque, May 2000, n° 17
12. Carr, D. Professionalism and Ethics in Teaching. New York, NY Routledge. 2000.
13. Galloux, J.C., Industrial Property Law. Dalloz 2003.
14. Wagret F. and J-M., Patent of invention, trademarks and industrial property. PUF 2001
15. Dekermadec, Y., Innovating through patents: a revolution with the internet. Insep 1999
16. AEUTBM. The engineer at the heart of innovation. University of Technology Belfort-Montbéliard
17. Fanny Rinck and Léda Mansour, Literacy in the Digital Age: Copying and Pasting Among Students, Université Grenoble 3 and Université Paris-Ouest Nanterre la Défense Nanterre, France
18. Didier DUGUEST IEMN, Citing your sources, IAE Nantes 2008

19. Similarity detection software: a solution to electronic plagiarism? Report of the Working Group on Electronic Plagiarism presented to the CREPUQ Subcommittee on Pedagogy and ICT
20. Emanuela Chiriac, Monique Filiatrault and André Régimbald, A Student's Guide: Intellectual Integrity, Plagiarism, Cheating and Fraud... avoid them and, above all, how to cite your sources, 2014.
21. Publication of the University of Montreal, Plagiarism Prevention Strategies, Integrity, Fraud and Plagiarism, 2010.
22. Pierrick Malissard, Intellectual Property: Origin and Evolution, 2010.
23. The World Intellectual Property Organization website www.wipo.int
24. http://www.app.asso.fr/

III - Detailed programme by subject of the S3 semester

Semester: 3
Teaching unit: UEF 2.1.1
Subject 1: Modeling and diagnosis of mechatronic systems
VHS: 67h30 (Lecture: 3h00, TD: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:

Master the graphical and analytical modeling tools of mechatronic systems
Know how to apply the bond graph approach for the diagnosis of mechatronic systems

Recommended prior knowledge:

The basic concepts of physics.Energy transfer – fundamental electronics – sensor and actuator – signal processing

Material content:

Chapter 1: Analytical Modeling Approaches:
Status space
Transfer function **(2 weeks)**
Chapter 2: Graphical Modeling Approaches:
Bond graph, Bipartite graphs and Directed graphs. **(2 weeks)**
Chapter 3: Elements of the Bond graph: Elements, Aspects,
Interest of the Bond graph. **(3 weeks)**
Chapter 4: Diagnosis of dynamical systems:
Analytical and Graphical Approaches
The bond graph method: observability, detectability, isolability. **(2 weeks)**
Chapter 5: Defect detection:
Residue generations
Generation of detection thresholds. **(2 weeks)**
Chapter 6: Fault isolation. **(2 weeks)**
Chapter 7: Estimation of defects. **(2 weeks)**

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1- *Les bond Graphs. G. Dauphin-Tanguy, HERMÈS / LAVOISIER, 2000.*
2- *Structured modeling of systems with Bond Graphs, Daniel Jaume and M. Vergé, 2003.*
3- *Model-based Process Supervision: A Bond Graph Approach, A. K. Samantaray & B. OuldBouamama.*

Semester: 3
Teaching unit: UEF 2.1.1
Subject 2: Fundamental technology of elements in mechatronics
VHS: 45h00 (Lecture: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The course allows the student to understand the functioning of the components of a mechatronic system such as sensors and actuators.

Recommended prior knowledge:

Basic knowledge of electronics (Transistor, diode, calculation of capacitance, inductance), hydraulics, and mechanics.

Material content:

Chapter 1: Introduction: reminders, Actuators: electric motors (DC, Stepper, Reciprocating), hydraulic motors, cylinders. Sensors: technologies (resistive, capacitive, passive, active, etc.) etc) **(2 weeks)**

Chapter 2: Conditioners. Mechatronic systems and elements: modelling, equations of states and simulation. **(3 weeks)**

Chapter 3: Modeling methods based on energy transfers between components of a system (Bond Graph, functional analysis).
• Structural properties. **(4 weeks)**

Chapter 4: Local Modeling Approach **(3 weeks)**
• Multi-physics finite element modeling.

Chapter 5: Applications on simple industrial systems **(3 weeks)**
Measurement and control interface via microcontrollers

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

References:

1) *Pascal Dassonvalle The Sensors,Dunod,2013*
2) *Electronics. Foundations and applications, exercises and solved problems.*
3) *José-Philippe Pérez, Christophe Lagoute, Jean-Yves Fourniols, Stéphane Bouhours Collection, Dunod 2014.*
4) *L. Pichon. Basics of Analog Electronics from Component to Integrated Circuit Corrected Courses and Exercises Level A, Ellipses Marketing, 2015. ISBN: 978-2340004047*
5) *S. Valkov. Analogue Electronics - Course with Solved Problems, Casteilla, 1998. ISBN: 978-2713513480*

Semester: 3
Teaching unit: UEF 2.1.2
Material 1: Embedded systems
VHS: 45h00 (Lecture: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Master the graphical and analytical modeling tools of mechatronic systems
Know how to apply the bond graph approach for the diagnosis of mechatronic systems

Recommended prior knowledge:

The basic concepts of physics.Energy transfer – fundamental electronics – sensor and actuator – signal processing

Material content:

***Part I**: Embedded microcontroller and microprocessor*

Chapter 1: Introduction
Reminder of the Von Neumann architecture - Von Neumann architecture vs Harvard architecture - CISC architecture vs RISC - History of microprocessor evolution and main manufacturers

(1 week)

Chapter 2: Embedded Microcontrollers and Microprocessors
Features, Use, and Benefits - Case Study: ARM Cortex M4 Microcontroller Microarchitecture - ARM Cortex A7 Microprocessor - ARM Cortex A15 Microprocessor

(3 weeks)

Chapter 3: RISC Processor Instruction Set: ARMv7-A
Data type - Addressing mode - Types of instructions

(3 weeks)

***Part II**: Embedded Operating Systems*

Chapter 1: Introduction to Operating Systems
Processes and Threads - Scheduling - Memory Management

(1 week)

Chapter 2: Embedded Operating Systems
History - Properties and Purposes - Areas of Use

(3 weeks)

Chapter 3: Real-time scheduling
Properties and constraints of real-time scheduling - Definitions: Real-time, strict real-time and flexible real-time - Real-time scheduling algorithms - Real-time in Linux -Different real-time approaches in Linux
Modifying the scheduler - Adding a new real-time kernel - Using RTLinux - Using kernel patches

(4 weeks)

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1- *F. Cottet & al., "Ordrement temps réel, cours et exercices correctes", Editions Hermès sciences,. Dorseuil, "Le temps réel en milieu industriel", Editions Dunod, 2000.*
2- *J.J. Montois, "Gestion des processus industriels temps réel", Ellipses, Technosup, 1999.*
3- *Christian Bonnet and Isabelle Demeure, "Introduction aux systèmes temps réel", Editions Hermès, Collection pédagogique de télécommunications ; 2007.*

4- *1. Nicolas Navet, Systèmes temps réel - Volume 1 - Technique de description et de verification, Edition - Hermès – Lavoisier, 2006.*
5- *2. Nicolas Navet, Systèmes temps réel - Volume 2 - Scheduling, networks and quality of service, Edition - Hermès – Lavoisier, 2006.*
6- *3. Franck Cassez and François Laroussinie, Contrôle des applications temps-réel - Modèles temporisés et hybrides, Edition - Hermès – Lavoisier, 2006.*

Semester: 3
Teaching unit: UEF 2.1.2
Subject 2: Control of dynamical systems
VHS: 45 h (Course: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

- Know how to analyze an open or closed regulatory loop
- Design and analysis of servo system regulators.

Recommended prior knowledge:

Mathematics – programming

Material content

Chapter 1: General information on dynamical systems
Definitions, terminologies, classification of dynamical systems **(1 week)**
Chapter 2: Servo Control of Dynamical Systems
Definitions - Interest of servo control - Classification of servo systems - Block diagrams **(1 week)**
Chapter 3: General study of dynamical systems
Introduction - Linear and Nonlinear Differential Equations - Common Signals - Laplace Transform - Transfer Function - Transfer Function Properties - Second-Order Systems - Frequency Study - Bode/Nyquist/Black-Nichols Diagrams - First/Second-Order Systems
- Examples of Systems **(3 weeks)**
Chapter 4: Stability of dynamical systems
Definition of stability - Stability criteria - Routh's criterion. **(2 weeks)**
Chapter 5: Graphical stability criteria
Nyquist Stability Criterion - Bode Diagram - Analysis by Nichols Charts. **(2 weeks)**
Chapter 6: Accuracy of Servo Systems
Definitions - Dynamic accuracy - Static precision. **(2 weeks)**
Chapter 7: Correcting Servo Systems
Specific corrections P, PI, PD, PID - Interaction between integral and derivative - Classic correction - Determination of correction parameters. **(2 weeks)**
Chapter 8: Study of dynamical systems in state space - State description - Command and solution of the state model - Passage from the state description to the transfer function - Passage from the transfer function to the state description - Commandability - Observability. **(2 weeks)**

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1- *E. Godoy. Industrial Regulation – 2nd Edition – Modeling Tools, Control Methods and Architectures, Dunod, 2014. ISBN: 978-2100717941*
2- *P. Prouvost. Automatique - Contrôle et régulation - Cours, exercices et problèmes correctes, Dunod, 2010. ISBN: 978-2100547777*
3- *P. Prouvost. Instrumentation and regulation - 2nd edition - In 30 sheets - Understanding and training easily, Dunod, 2015. ISBN: 978-2100726912*
4- *Signal et communications [texte imprimé]: modulation, codage et théorie de l'information Brémaud, Pierre Paris: Ellipses, 1995*
5- *Theory and Practice of the Signal [printed text]: deterministic and random signals in continuous and discrete Tanguy, Jean-Pierre Paris: Ellipses, 2007*
6- *Theory and signal processing. 1, Representation of signals and systems [printed text]: corrected courses and exercises Benidir, Messaoud Paris: Dunod, 2002*

Semester: 3
Teaching unit: UEM2.1
Subject 1: Lab Embedded Systems
VHS: 22h30 (WP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

Master and design automated systems. To be able to intervene in the systems as part of maintenance.

Recommended prior knowledge:

Basic notions in mathematics, algorithms and programming.

Material content:

Lab 1: Configuring a Linux embedded system for qemu

a. Introduction to qemu
b. Kernel, boot, and file system configuration
c. Simulation of an ARM architecture

Lab 2: Programming ARM processors

Lab 3: Development model for embedded systems

d. Heterogeneity of target architectures
e. Cross-compilation
f. Introduction to binutils
g. Cross-Compile Options

Lab 4: Real-time scheduling in the Linux kernel.

Lab 5: realization of a speed regulation system for a DC motor, which includes input and display peripherals,

Platform: Software: Proteus-Isis/ MicroC; Hardware: (microcontroller-based development system)

With the given synoptic diagram, and in an order of increasing complexity:

Step 1: programming, individually, of each hardware element, by classical algorithmics, (simulation) (6 hours/student)

Step 2: programming, of the real-time system, (simulation/assembly) (6 hours/student)

Step 3: programming, of the system in real time, (realization, assembly) (6 hours/student)

Evaluation method:

Continuous assessment: 100 %.

Bibliographical references:

1. J. Dordoigne, Computer Networks: Fundamental Concepts, 5th edition, 2012.
2. C. Servinet, J-P. Arnau, Réseaux et télécoms, 4th edition, Dunod, 2013.
3. G. Pujolle, Cours réseaux et télécoms: avec exercices correctes, 3rd edition, Eyrolles, 2008.
4. D. Dromard, D. Seret, Network Architecture, SYNTEX collection, 2009.

   Ph. Atelin, Computer Networks: Fundamental Notions (Standards, Architecture, OSI Model, TCP/IP, Ethernet, Wi-Fi), Edition ENI, 2009.

Course Notes and Methodical Lab Overviews

Semester: 3
Teaching unit: UEM 2.1
Material 2: CAD/CAM Computer-Aided Design and Manufacturing
VHS: 45h00 (Course: 1h30, WP: 1h30)
Credits: 3
Coefficient: 2

Teaching objectives:

Study the different traditional design and manufacturing techniques in order to produce mechanical parts.

Recommended prior knowledge:

General mechanics – manufacturing – Drawing.

Material content:

Chapter 1: Manufacturing Process
Production processes (metalworking processes, ceramics, semiconductors) turning, milling, cutting, drilling etc.
Thin and thick sheet technologies
Processing of plastics.
Chapter 2: CAD/AUTO CAD/CIM Computer-Aided Design
Computer-aided design
Development and design of components, devices and equipment using modern software tools (CAD, AUTO CAD, etc.)
Application of EEI Methods in Strain Technology
Chapter 3: Manufacturing Technology and Methods Tools
Project-based studies
Preparation of machining (machining range, manufacturing dimensions, adjustment dimensions)
Machining setup
CAD-CAM LINK: CAD/CAM (programming of numerical control machines)
Tool management and monitoring

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1- *Jean-Claude Leon, "Modélisation et construction de surfaces pour la CAD/CAM", Ed. Hermès, Paris, 1991.*
2- *Gerald Farin, "Curves and Surfaces for CAGD", Ed. Academic Press, 2002.*
3- *M. Hosaka, "Modelling of Curves and Surfaces in CAD/CAM", Ed. Springer Verlag, 1992.*
4- *David F. Rogers, "An Introduction to NURBS with Historical Perspective", Ed. Academic Press, 2001.*
5- *Cornand, F. Kolb, "Usinage et contrôle numérique", Ed. Foucher, 1987.*

Course Notes and Methodical Lab Overviews

Semester: 3
Teaching unit: UEM2.1
Subject 3: Practical work Modeling and diagnosis of mechatronic systems
VHS: 37h30 (WP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

The objective of this module is to introduce students to the different techniques of modeling and automatic detection of defects as well as their different applications in industry.

Recommended prior knowledge:

Statistics and probability, linear algebra, Matlab use.

Material content:

Lab 1: Simulation of a simple industrial system

Lab 2: Simulation of a neural network model

Lab 3 : Modeling a defect in a mechatronic system

Lab 4: Application of diagnostics in a mechatronic system
- Location and detection

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1- *Hewit, J. (1996). Mechatronics design - the key to performance enhancement. Robotics and Autonomous Systems, 19:135–142.*
2- *Isermann, R. (2007). Mechatronic systems - innovative products with embedded control. Control Engineering Practice, 10:16.*
3- *Jelinski, Z. and Moranda, P. (1972). Software Reliability Research. Statistical Computer Performance Evaluation.*
4- *Khalfaoui, S. (2003). Method for researching the feared scenarios for the evaluation of the dependability of mechatronic systems in the automotive world. PhD thesis, Institut National Polytechnique de Toulouse.*

Course Notes and Methodical Lab Overviews

Semester: 3
Teaching unit: UEM2.1
Subject 3 : Practical work Control of dynamic systems
VHS: 37h30 (WP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

The objective is to allow the student to become familiar with the modeling and simulation of dynamical systems while solving problems in the design of control systems.

Tutorials 1 and 2: Reminders on the modeling and simulation of systems by algorithmic methods and block diagrams (depending on the institution's resources: MATLAB/Simulink, ...).
TP 3: Frequency study of dynamical systems.
TP 4: Stability of dynamical systems.
TP 5: Correction of dynamic systems.
Lab 6: Modeling by state model.
TPs 7 and 8: Design of controlled systems.

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1- *E. Godoy. Industrial Regulation – 2nd Edition – Modeling Tools, Control Methods and Architectures, Dunod, 2014. ISBN: 978-2100717941*
2- *P. Prouvost. Automatique - Contrôle et régulation - Cours, exercices et problèmes correctes, Dunod, 2010. ISBN: 978-2100547777*
3- *P. Prouvost. Instrumentation and regulation - 2nd edition - In 30 sheets - Understanding and training easily, Dunod, 2015. ISBN: 978-2100726912*
4- *Signal et communications [texte imprimé]: modulation, codage et théorie de l'information Brémaud, Pierre Paris: Ellipses, 1995*
5- *Theory and Practice of the Signal [printed text]: deterministic and random signals in continuous and discrete Tanguy, Jean-Pierre Paris: Ellipses, 2007*
6- *Theory and signal processing. 1, Representation of signals and systems [printed text]: corrected courses and exercises Benidir, Messaoud Paris: Dunod, 2002*

Semester: 3
Teaching unit: UEF 2.1
Subject 2: Reverse Engineering
VHS: 45h00 (Lecture: 1h30, workshop: 1h30)
Credits: 2
Coefficient: 2

Teaching objectives:

- Understand the principles and objectives of Reverse Engineering (RE) in the field of science and technology (ST),
- Become familiar with RE tools and methods in the relevant specialization,
- Learn the value and ethics of RE principles in product design, manufacturing, and quality assurance,
- Encourage critical thinking, technical curiosity, reasoned reverse engineering, and innovation,
- Learn to analyze, document, and model an existing system without initial documentation.

Skills targeted

- Decompose and analyze an existing system,
- Accurately reproduce a technical diagram or 3D model from an existing product,
- Apply diagnostic and simulation tools,
- Work in a group on an exploratory project,
- Identify the legal limitations of reverse engineering

Adaptability to the specializations within the Science and Technology field

- All specializations within the ST field are relevant, as follows:
- Examples of tasks: Digital technical documentation, results of technology monitoring, technical project management, collaboration on plans, report analysis, understanding of industrial processes, production data monitoring, reporting techniques, prototyping, testing)

Recommended prior knowledge:

Fundamental knowledge in the specialty.

Material content:

1. Introduction to Reverse Engineering
- History, legal and ethical issues of RE,
- Definitions and fields of application: Approaches (hardware, software, processes…)
- Domains: maintenance, remanufacturing, cybersecurity, competitive intelligence

2. General Methodology
- Analysis of a "black box" system
- Functional decomposition
- Block diagrams, input/output diagrams, energy or information flow diagrams

3. Hardware Reverse Engineering
- Electronic boards: visual inspection, component identification
- Use of tools: multimeter, oscilloscope, logic analyzer
- Electronic schematic recognition
- Schematic reconstruction using KiCad/Proteus

4. Software Reverse Engineering
- Static analysis of binaries (e.g., .exe, .hex)
- Decompilation, disassembly (introduction to Ghidra, IDA Free, or Hopper)
- Observation of behavior: sniffing, monitoring (e.g., Wireshark)

- Microcontrollers: flash memory reading, firmware extraction

5. Mechanical Reverse Engineering
- 3D scanning: scanning, manual measurements
- Reproduction of CAD models from existing parts
- Software used: SolidWorks, Fusion 360

6. Security and Intrusion Detection
- Reverse engineering in cybersecurity: malware detection, vulnerabilities
- Software signing, protections against reverse engineering (obfuscation, encryption)

7. Real-world case studies
- Analysis of an obsolete or unknown product (mouse, power supply, Bluetooth module, etc.)
- Example of reverse engineering of a mechanical part or simple system (fan, housing)

Examples of practical work (based on the 4 Engineering fields)

• **Electrical Engineering:**
- Reverse engineering of an electronic module without a schematic
- Example: Bluetooth module, time-delay relay
- Objectives: identify the operation, draw the schematic, propose an improved version.
- Identification of components (ICs, transistors, resistors, etc.).
- Use of tools: multimeter, oscilloscope, logic analyzer.
- Reading and extracting firmware from a microcontroller.
- Introduction to the detection of electronic counterfeits.

• **Mechanical Engineering:**
- Reverse engineering of a simple mechanism
- Examples: hand pump, torque wrench, mini-press...
- Mechanical disassembly of a system (pump, gear, cylinder...)
- Measurements and reconstruction of plans or 3D models using CAD software (SolidWorks, Fusion 360)
- Identification of materials and manufacturing methods
- Functional simulation based on the recreated model

• **Civil Engineering:**
- Analysis of existing structures without plans (walls, slabs, structures, etc.).
- Examples: metal staircase, window sill, formwork.
- Study and reverse engineering of an existing structural element.
- Identification of materials, connections, and constraints.
- Modeling of the structure using Revit, AutoCAD, or SketchUp.
- Study of the rehabilitation or reproduction of existing structural elements.

• **Process Engineering:**
- Reverse engineering of a laboratory module
- Examples: simple instruments, distillation, filtration, heat exchanger, reactor…
- Analysis of existing industrial systems (distillation column, heat exchanger, reactor…).
- Reconstruction of PFD and PID diagrams from observation of an installation.
- Identification of sensors, actuators, and control devices.
- Study of mass/energy flow in a process.

Evaluation method :

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

– Reverse Engineering for Beginners – Dennis Yurichev (gratuit en ligne)

- The IDA Pro Book – Chris Eagle (logiciels)
- Practical Reverse Engineering – Bruce Dang
- Documentation :
    - https://ghidra-sre.org
    - https://www.kicad.org
    - https://www.autodesk.com/products/fusion-360

Semester: 3
Teaching unit: UET2.1
Subject: Literature research and memory design
VHS: 22h30 (Lecture: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:
Give the student the necessary tools to look for useful information in order to better use it in his or her end-of-studies project. Help them go through the different steps leading to the writing of a scientific document. To show them the importance of communication and to teach them to present the work done in a rigorous and educational way.

Recommended prior knowledge:
Methodology of writing, Methodology of presentation.

Material content:

Part I-: Documentary research:

Chapter I-1: Definition of the Subject (02 weeks)
- Subject Title
- List of keywords relevant to the topic
- Gather basic information (acquisition of specialized vocabulary, meaning of terms, linguistic definition)
- The information sought
- Take stock of your knowledge in the field

Chapter I-2: Select sources of information (02 weeks)
- Type of documents (Books, Theses, Dissertations, Periodical Articles, Conference Proceedings, Audiovisual Documents, etc.)
- Type of resources (Libraries, Internet, etc.)
- Assess the quality and relevance of information sources

Chapter I-3: Locate documents (01 Week)
- Research techniques
- Search operators

Chapter I-4: Processing information (02 weeks)
- Work organization
- The initial questions
- Summary of the selected documents
- Links between different parties
- Final plan of the literature search

Chapter I-5: Presentation of the bibliography (01 Week)
- The systems of presenting a bibliography (the Harvard system, the Vancouver system, the mixed system, etc.)
- Presentation of documents.
- Citation of sources

Part II: Memory Design

Chapter II-1: Outline and stages of the thesis (02 weeks)

- Identifying and Defining the Subject (Summary)
- Problem and objectives of the dissertation
- Other useful sections (Acknowledgements, Table of Abbreviations, etc.)
- The introduction (*The writing of the introduction last)*
- State of the specialized literature
- Formulating the hypotheses
- Methodology
- Results
- Discussion
- Recommendations
- Conclusion and outlook
- The Table of Contents
- Bibliography
- Appendices

Chapter II-2: Writing techniques and standards **(02 weeks)**
- Formatting. Numbering of chapters, figures and tables.
- The cover page
- Typography and punctuation
- The editorial staff. Scientific language: style, grammar, syntax.
- Spelling. Improved general language proficiency in comprehension and expression.
- Backup, secure, archive your data.

Chapter II-3: Workshop: Critical study of a manuscript **(01 Week)**

Chapter II-4: Oral presentations and defenses **(01 Week)**
- How to Present a Poster
- How to present an oral communication.
- Defense of a thesis

Chapter II-5: How to Avoid Plagiarism ? **(01 Week)**
(Formulas, phrases, illustrations, graphs, data, statistics,...)
- The quote
- Paraphrasing
- Indicate the complete bibliographic reference

Method of evaluation:
Review: 100%

References:

1. *M. Griselin et al., Guide de la communication écrit, 2nd edition, Dunod, 1999.*
2. *J.L. Lebrun, Guide pratique de rédaction scientifique: comment écrire pour le lecteur scientifique international, Les Ulis, EDP Sciences, 2007.*
3. *Has. Mallender Tanner, ABC de la rédaction technique: modes d'emploi, instructions d'utilisation, aides en ligne, Dunod, 2002.*
4. *M. Greuter, Bien rédaction son mémoire ou son rapport de stage, L'Etudiant, 2007.*
5. *Mr. Boeglin, reading and writing at university. From the chaos of ideas to the structured text. L'Etudiant, 2005.*
6. *M. Beaud, l'art de la thèse, Editions Casbah, 1999.*
7. *M. Beaud, l'art de la thèse, La découverte, 2003.*
8. *M. Kalika, Le mémoire de Master, Dunod, 2005.*
1. *, 2005.*

IV- Detailed programmes by subject
Some of the UE discovered (S1, S2, S3)

Semester: X
Teaching unit: UED XX
Material: Tribology
VHS: 22h30 (CT: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The aim is to show the principle of analysis and characterization of the surface conditions of materials. The study of wear problems and deformations.

Recommended prior knowledge:

Mechanics – RDM – thermodynamics

Material content:

Chapter 1. : Introduction. History - tribology in industry - Economic considerations. **(2 weeks)**

Chapter 2.: Surfaces and interfaces. Definitions, concepts and criteria - Surface analysis and characterization -Functional properties of surfaces -Friction and deformation of surfaces -Wear: definition and wear modes. **(3 weeks)**

Chapter 3.: Friction. Introduction - Possible causes of friction - Adhesion theory - Introduction of friction theories - Influence of intrinsic material properties on friction - Test methods - Choice of materials. **(2 weeks)**

Chapter 4. : Abrasion. Definition and principle - Two-body abrasion - Three-body abrasion - Influence of operating parameters on abrasive wear - Influence of parameters related to abrasive particles - Influence of load - Influence of speed - Influence of the environment - Influence of the nature of the materials - Test methods - Choice of materials. **(2 weeks)**

Chapter 5. : Lubrication. Lubrication regimes • Hydrostatic lubrication • Hydrodynamic lubrication Limit lubrication (mixed) . Studies of the parameters in the contact - Pressure in the film - Load supported by the contact. Flow rate - Force or torque of friction - Reynolds equation. Interpretation - Elementary case studies of lift. Stretching Effect -Crush Effect - Oil Wedge. . **(3 weeks)**

Chapter 6.: Surface coatings. General - Surface coating processes- Surface preparation - Special processes - Industrial applications. **(3 weeks)**

Evaluation method:

Review: 100%.

Bibliographical references:

1. *Georges, Friction, wear and lubrication: Tribology or surface science, Eyrolles, 2000.*
2. *Hamid Zaidi, J. Rivière, Lubrication and tribology of thin coatings, Presses Polytechniques Romandes, 2010.*
3. *Jean-Marie Georges Friction, wear and lubrication: Tribology or surface science, Publisher: CNRS Editions, 2000*
4. *Yannick Desplanques , Gérard Degallaix, Tribologie et coupplages multi physiques, 2006, Publisher : Presses Polytechniques et Universitaires Romandes.*

Semester: X
Teaching unit: UED XX
Material: CNC manufacturing processes
VHS: 22h30 (CT: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Study the different traditional manufacturing techniques in order to produce mechanical parts in line with their design.

Recommended prior knowledge:

General mechanics – manufacturing – Drawing.

Material content:

Chapter 1. : Conventional manufacturing techniques. Choice and influence of cutting parameters - Surface finish and geometric defects - Study of the parts taken. **(4 weeks)**

Chapter 2. : CNC machine. Control Range - Product acceptance condition and measurement uncertainty. Forging, foundry, sheet metals, welding. **(5 weeks)**

Chapter 3. : Advanced manufacturing techniques. Composite manufacturing
- Conventional (mechanical or thermal) and special (shot peening, prestressing, etc.) surface treatment - High-speed machining
- Unconventional machining (ultrasonic, EDM, water jet, laser, etc.)
- Rapid prototyping. Three-dimensional metrology (macroscopic and nanoscopic scales).

(6 weeks)

Evaluation method:

Exam : 100%

Bibliographical references:

1. *Cornand, F. Kolb & J. Lacombe. "Usinage et contrôle numérique", T2, 1992.*
2. *G. Faidherbe & B. Vacossin, Cetim. "The Environment of Machining Centres", Senlis, 1991.*
3. *B. Froment & J.-J. Lesage. Production. "Les techniques de l'usinage flexible", Dunod, Paris, 1988.*
4. *P. Gonzalez. "La Commande numérique par ordinateur : tournage, millage, centres d'usinage ", Casteilla, Paris, 1993.*
5. *C. Hazard. "La Contrôle numérique des machines-outils", Foucher, 1984.*
6. *Vander, "Machine-tools: calculations, fundamental bases, construction elements", Brussels, 1969.*
7. *C. Marty, C. Cassagnes & P. Marin. "La Pratique de la contrôle numérique des machines-outils", Tec & Doc, Paris, 1993.*
8. *J. W. Oswald & S. F. Krar. "Technology of Machine Tools," McGraw-Hill, New York, 4th ed. 1989.*
9. *A. Cornand, F. Kolb & J. Lacombe, "Usinage et contrôle numérique", t. II, Foucher, Paris, 1992.*

Semester: X
Teaching unit: UED XX
Material: Renewable energies microsystems
VHS: 22h30 (CT: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Acquire basic knowledge about the production of electrical energy from renewable energies (wind, solar photovoltaic, heat pumps, etc.).
Also acquire a general culture on the energy issues of our society and to understand the essential notions relating to the different sources of renewable energy.
For each of the technologies, understand how an installation works, know how it is implemented, take into account the environmental impact of the installation and its maintenance, and carry out a feasibility study.
Finally, to understand the economic aspects of the integration of intermittent renewable energies into competitive electricity markets.

Recommended prior knowledge:

Thermodynamics – sensor and conditioner – thermal.

Material content:

Chapter 1. : Introduction to renewable energies, global energy issues renewable energies: definition and challenges. **(2 weeks)**
Chapter 2.: Wind energy. **(2 weeks)**
Chapter 3. : Photovoltaic solar energy. **(2 weeks)**
Chapter 4. : Solar thermal energy. **(3 weeks)**
Chapter 5. : Hydroelectricity, Geothermal Energy, Cogeneration and Biogas. **(3 weeks)**
Chapter 6. : Hybrid systems (techno-economic study). **(3 weeks)**

Evaluation method:

Examination: 100%.

Bibliographical references:

Books and handouts, websites, etc

Semester: X
Teaching unit: UED XX
Subject:Theory of mechanisms and systems
VHS: 22h30 (CT: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Acquisition of the basic tools of the theory of mechanisms. Use and development of systems tools. Setting up the necessary tools during mechanical engineering.

Recommended prior knowledge:

General mechanics – RDM.

Material content:

Chapter 1. : Representation of displacements of solid matrices of passage - finite rotations. **(3 weeks)**

Chapter 2. : Direct and inverse geometric models of a serial robot. Coordinate transformation, variational and kinematic models - notion of dynamic model, application to control - programming elements and simulation in robotics. **(6 weeks)**

Chapter 3. : Robot technology: axes, transmissions, wrists. Robot programming lab in the context of a robotic platform. **(6 weeks)**

Evaluation method:

Review: 100%.

Bibliographical references:

Books and handouts, websites, etc

Semester: X
Teaching unit: UED XX
Material : Numerical methods
VHS: 22h30 (CT: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The aim is to show on classical types of problems what a master's degree in mechatronics can do when he has to give a quantitative answer to a problem for which the theory does not answer, but he has a computer.

Recommended prior knowledge:

Mathematics - Computer Science

Material content:

Chapter 1. : **Formulation of finite differences**
- Difference schemes applied to PDEs - 1D and 2D ellipticals - Four and nine point schemes - Calculation algorithm on machine. **(2 weeks)**

Chapter 2.: Parabolic 1D and 2D. Diagrams: - Richardson – Explicit – Implicit – Crank Nicholson – Theta Diagram – PeacemanRachford:
implicit alternating directions. **(2 weeks)**

Chapter 3.: Convergence, Consistency, and Stability of Parabolic Patterns
-Matrix methods or Fourier analysis
-Hyperbolic 1D and 2D - Method of characteristics - Classical schemes (explicit centered in space, off-center in space, of Lax-Friedrich, Leap-Frog, Lax-Wendroff, of Godunov.
(2 weeks)

Chapter 4. : Variational methods - Ritz method - Galerkin method - Least squares collocation method. **(2 weeks)**

Chapter 5.: General presentation of the finite element method: 1D and 2D
Essential steps of m e f - Discretization of a continuous medium - Different types of elements, order of approximation - Elementary equations, assembly - Introduction of boundary and initial conditions - Methods of direct or iterative resolution - Presentation of results**.**
(2 weeks)

Chapter 6.: Solving a problem with one-dimensional fields.
- Discretization by linear elements in one dimension - Variational formulation - Elementary equations - Assembly. overall system -Introduction of boundary conditions-Resolution - Application: beam, heat transfer. **(2 weeks)**

Chapter 7.: Solving a Two-Dimensional Field Problem
-Discretization by linear elements T3 and Q4 -Variational formulation. Elementary matrices - Different coordinate systems (local, natural, barycentric) - Introduction of boundary conditions on elements - Assembly. Global System-Resolution. Application: Plate, Heat Transfer. **(3 weeks)**

Evaluation method:

Examination 100%.

Bibliographical references:

Semester: X
Teaching unit: UED XX
Material: Turbomachine
VHS: 22h30 (CT: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

- Acquisition of basic knowledge of turbomachinery
- Learn the principles of energy conversion, turbocharger, turbine

Recommended prior knowledge:

Physics, Thermodynamic Mechanics.

Material content:

Chapter 1. : General. Definition, Principle of operation, Classifications of turbomachinery, General theory, Euler's theorem, Speed diagram, Height, Power, Losses and efficiency of turbines and pumps, Component of the energy transferred, Degree of reaction, Load variation, Degree of reaction. . **(3 weeks)**

Chapter 2.: Similarity. General Relations, RATEAU Invariants, Other Coefficients, Similar Operating Machines, Generalization,
Specific speed. **(2 weeks)**

Chapter 3. : Pumps. General relations, Centrifugal pumps and axial pumps, Descriptions, speed triangles, efficiency. **(3 weeks)**

Chapter 4. : Cavitation. Origin and criteria of the cavitation Manifestation, Influence of different factors, Similarity of cavitation. **(2 weeks)**

Chapter 5. : Turbochargers. General, General Equations of Turbochargers, Centrifugal Turbochargers, Axial Turbochargers. **(2 weeks)**

Chapter 6.: Turbines. Water Turbines, Steam Turbines, Gas Turbines,
Turbo engines. . **(3 weeks)**

Evaluation method:

Examination 100%.

Bibliographical references:

1. *. Cabannes, "Problems of General Mechanics", Dunod (1966).*
2. *M. Combarnous, D. Desjardin & Ch. Bacon, "Mécanique des solides et des systèmes de solides", Dunod (2004).*
3. *Joseph-Louis Lagrange. Analytical mechanics. Reprint of the original edition of 1778. Editions Jacques Gabay, Paris, 1989.*

Semester: X
Teaching unit: UED
Subject Title: Metrology and Quality
VHS: 22h30 pm (lecture: 1 h 30)
Credits: 1
Coefficients: 1

Teaching objectives

• Master the quality management system and know the metrological requirements in an organization in the industrial sector.
• Know how to implement the fundamental tools of the quality approach and the metrology function.
• Know how to be part of a process of progress.

Recommended Prior Knowledge

Mathematics

Material content

Chapter 1: Introduction to Quality Management **(3 weeks)**
1.1 Context, issues and principle1.2 The place of metrology
1.3 Discovery of Master Repositories

Chapter 2: Introduction to Metrology **(3 weeks)**
2.1 Perspectives, objectives and constraints2.2 Traceability and organization of metrology2.3 Legal metrology

Chapter 3: The Fundamentals of Metrology **(4 weeks)**
3.1 Measurement, testing and analysis processes 3.2 Statistical approach to measurement, results 3.3 Performance of measuring instruments, vocabulary, life record

Chapter 4: Characterization of the results **(3 weeks)**
4.1 Performance evaluation and monitoring (respectability and reproducibility)4.2 Validation of methods

Chapter 5: Measuring instruments **(2 weeks)**
5.1 Traceability (verification, calibration, reference material)5.2 Measuring instrument park and monitoring, reliability and operational safety

Method of evaluation:

Examination : 100%.

References

1. *Jean-Claude Engrand, De la métrologie fondamentale à son application industrielle – Éditeur Librairie scientifique Albert Blanchart, 1976.*
2. *Jean Perdijon – La mesure science et philosophie – Collection Domino, Publisher Flammarion1998 (ISBN 02-08-035580-5)*
3. *A.Defix – Element of General Metrology and Legal Metrology – École nationale supérieure du pétrole et des moteurs – Technip Edition -1985 (2nd edition) (ISBN 2-7108-0496-4)*
4. *C.Joffin, F.Lafont, E.Mathieu "Measurements and Instrumentation – Laboratory Sciences and Technologies" –- Caroline Bonnefoy collection at Casteilla (2012)*

Semester: X
Teaching unit: UED
Title of the subject: *Smart Sensor*
VHS: 22h30 (lecture: 1 h 30)
Credits: 1
Coefficients: 1

Teaching objectives

The student can gain general knowledge about smart sensors. And to deepen this knowledge in the form of practical sessions on this subject so that the student can know this kind of sensors and the communication between them up close.

Recommended Prior Knowledge

Sensors, IT

Material content

Part I: Courses

Chapter 1: Fundamentals **(1 week)**

Sub-Chapter 1: Communication and Routing Protocols **(1 week)**

Chapter 2: Smart Sensors **(2 week)**

- Geographic Routing (Based on Real and Virtual Coordinates)

Chapter 3: Wireless Sensor Networks **(4 weeks)**

- Wireless Networks (Cellular Network, AdHoc, MANET, VANET)
- Sensor Networks(1 week)

Chapter 4: Routing in Sensor Networks **(1 week)**

Chapter 5: Internet of Things (IoT)(1 week)

Part II: Presentations

Evaluation method:

Examination: 60%; Continue: 40%.

References

1. *I.F. AKYILDIZ, W. SU, Y. SANKARASUBRAMANIAM, E. CAYIRCI, Wireless sensornetworks: a survey, Book: Broadband and Wireless Networking Laboratory, School of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta USA,December 2001.*
2. *STOJMENOVIC, Sensor Networks, in: S. OLARIU, Q. XU, A. WADAA, and I.*
3. *STOJMENOVIC, Virtual Infrastructure for Wireless Sensor Networks, Book style, 2005.*
4. *G. Asch, B. Poussery, SENSORS IN INDUSTRIAL INSTRUMENTATION, 8th edition, DUNOD, 2017*
5. *K. BEYDOUN, Conception d'un protocole de routing hierarchique pour les réseaux decapteurs, Doctoral thesis presented at the U. F.R of Science and Technology of the University of FRANCHE-COMTE, France, December 2009.*
6. *Y. CHALLAL, Wireless Sensor Networks, Course, Intelligent Systems for Transport, University of Technology of Compiègne, France, 17 November 2008.*
7. *M. CARTRON, Towards an energy-efficient platform for wireless sensor networks, Thesis to obtain the degree of: Doctor of the University of RENNES 1 (Option Signal Processing and Telecommunication), December 2006.*
8. *Gary W. Hunter, Joseph R. Stetter, Peter J. Hesketh, Chung-ChiunLiuSmartSensorSystems, Chapterfrom book Nanodevices and Nanomaterials for Ecological Security, 2012*
9. *K. AKSA, Proposal of a virtual coordinate system for the resolution of the routing problem in wireless sensor networks, thesis to obtain the degree of Doctor of Science in Computer Science, December 2013.*

Semester: X
Teaching unit: UED
Subject Title: Mechatronics in the Smart Factory
VHS: 22h30 (lecture: 1 h30)
Credits: 1
Coefficients: 1

Teaching objectives

This subject aims to introduce students to the new generation of mechatronics. The latter makes the factory of the future digital, smarter, flexible and connected. This plant will also be more environmentally friendly and sustainable. Taking into account the major trends in industrial automation and the specific needs of customers has given rise to a new generation of mechatronics. Equipped with smart sensors, robotics, IoT, Big Data... etc., the digital factory offers immediate benefits while meeting long-term challenges.

Recommended Prior Knowledge

electronics, embedded system

Material content

Chapter 1: Industry 4.0 and the Smart Factory

- Industrial Revolutions - From Industry 1.0 to Industry 5.0
- Definition of Industry 4.0
- Components of Industry 4.0
- Product Lifecycle
- The Architectural Model of Industry 4.0 (RAMI 4.0)
- Five Key Features of a Smart Factory
- Expected benefits and benefits of Industry 4.0

Chapter 2: New technologies for the factory of the future

- Virtual, augmented and mixed reality
- Smart Sensors and RFID (Radio Frequency IDitification)
- IoT (Internet of Things) and Coud computing
- Data science, Data Mining and Big data
- Machine and Deep Learning
- Additive Manufacturing
- Cobotics
- Cyber and Cybersecurity

Chapter 3: Smart Sensors: The Basis of the Digital Factory

- Definition of a smart sensor
- Role and characteristics of a smart sensor
- Smart Sensor Architecture
- The entities of a Smart Sensor
- Types of Smart Sensors
- Classification of areas of application

Chapter 4: Sensor Networks

- Definition of a sensor network
- Sensor deployment
- Protocol stack in sensor networks
- Characteristics, constraints and design factors of sensor networks
- Topologies and transmission models
- Routing and Factors Influencing the Design of a Routing Protocol
- Routing Strategies in Sensor Networks

Chapter 5: Moving from a Regular Factory to a Smart Factory

- Steps to Transform an Ordinary Factory into a Smart Factory
- Important issues
- Criteria for choosing new technologies
- Application example: Factory design and simulation using Factory IO
- Smart factories around the world

Evaluation method:

Review: 100%;

References

1. *MortezaGhobakhloo, Mohammad Iranmanesh, Digital transformation successunderIndustry 4.0: a strategic guideline for manufacturingSMEs, Journal of ManufacturingTechnology Management, 2021. https://doi.org/10.1108/JMTM-11-2020-0455*
2. *Marc Batty, Médéric Morel, Jean-Luc Raffaëlli, Big Data and Machine Learning - 3rdedition, The concepts and tools of data science, Dunod, 2019.*
3. *Carlos Toro, Wei Wang, HumzaAkhtar, ImplementingIndustry 4.0: The Model Factory as the Key Enabler for the Future of Manufacturing, Springer; 1st ed. 2021 edition (April 4, 2021)*
4. *Vikram Bali, VishalBhatnagar, DeeptiAggarwal, Shivani Bali, Mario José Diván, Cyber-Physical, IoT, and AutonomousSystems in Industry 4.0, Taylor & Francis eBooks, 1st Edition 2021*
5. *Farzad Pour Rahimian, Jack Goulding, SepehrAbrishami, Saleh Seyedzadeh, Faris Elghaish, Industry 4.0 Solutions for Building Design and Construction: A Paradigm of New Opportunities, Routledge; 1st edition (December 21, 2021).*

Summary table of experts

Name and surname of the expert teacher	***Establishment***	***Matter***
LAIFAOUI Abdelkrim	*University of Bejaia*	*Pairing of two transversal subjects and the incorporation of another subject*

- ***Ethics, deontology and intellectual property***
- ***Research Methodology*** *Erreur ! Source du renvoi introuvable.*

Erreur ! Source du renvoi introuvable.Erreur ! Source du renvoi introuvable.

LATRECHE Khaled	*University of Batna 2* ***Problems:*** *Redundancy (Chapter 5, Industrial Programmable Logic Controllers (PLCs) will be studied in semester 2 under the module "Architecture and Programming of Industrial Programmable Logic Controllers")*	***1. Automatism*** ***2. TP APAP*** ***Architecture and Programming of PLCs*** *The updates concern:* • *The content of the material*

- ***Automatism*** Erreur ! Source du renvoi introuvable.
- ***APAPI*** Erreur ! Source du renvoi introuvable.
- ***TP APAPI*** *Erreur ! Source du renvoi introuvable.*

BENSAADI Rafik	*University of Batna 2* **Industrial regulation.** *- Insufficient hourly volume: 4.5 hours per week, at least, necessary,* *- Absence of a corresponding practical work module)* *- Practical work/ Signal processing Semester 1: (to be enriched)* *-TP/ Embedded systems Semester 3: (to be enriched)* - *Proposal of new materials discovered and/or transversal, history of the evolution of control systems. –From analog to digital*	***Industrial Regulation*** *The updates concern:* • *The content of the material*

- ***Industrial regulation*** *Erreur ! Source du renvoi introuvable.*

		- ***TP/ Signal processing*** - ***TP / Embedded Systems***
Karima AKSA	*University of Batna 2*	***Smart Sensor*** *The updates concern:* *Dr. Aksa proposed the content of UE Covered Smart Sensor.*
		- ***For the Material Smart Sensor***
Hanane Zermane	*University of Batna 2*	***Telecommunication Applications*** *The updates concern:* *Dr. Zermane proposed the content of UE Covered Telecommunication Applications.*
		- ***Telecommunication Applications***
NEZAR Malika	*University of Batna 2*	***Diagnosis by vibration analysis.*** *The updates concern:* *- the continuous of matter* *-Prerequisite*
		- ***Diagnostics by vibration analysis***
(Pr BENMOHAMMED)	*University of Batna 2*	***Proposal for a new Teaching Unit: UED Mechatronics in the Smart Factory proposed by ....***