HARMONIZED ACADEMIC MASTER
National Program
Update 2025

Domain	Stream	Specialty
Science and Technologies	Mechanical Engineering	Mechanical Construction

I – Master's Identity Sheet

Access Conditions

Stream	Harmonized Master	Licenses granting access to the master	Ranking according to compatibility	Coefficient assigned to license
Mechanical Engineering	Mechanical Construction	Mechanical Construction	1	1.00
		Energetics	2	0.80
		Civil Engineering	3	0.70
		Public Works	3	0.70
		Other S&T domain licenses	5	0.60

II – Semester-based Organization Sheets of the Specialty's Courses

Semester 1: Mechanical Construction

Teaching Unit	Subjects Title	Cred.	Coef.	Weekly Vol. Lec.	Tut	Lab	SCH (15 w)	Comp. Work	Evaluation CA	Exam
Fundamental Unit Code: CU 1.1.1 Credits: 10 Coeff: 5	Continuum mechanics	6	3	3h00	1h30		67h30	82h30	40%	60%
	Advanced strength of materials	4	2	1h30	1h30		45h00	55h00	40%	60%
Fundamental Unit Code: CU 1.1.2 Credits: 8 Coeff: 4	Internal combustion engines	4	2	1h30	1h30		45h00	55h00	40%	60%
	Applied fluid mechanics	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological Unit Code: MU 1.1 Credits: 11 Coeff: 7	Lab FM/MoM	2	1			1h30	22h30	27h30	100%	
	Conventional and advanced manufacturing techniques	4	2	1h30		1h30	45h00	55h00	40%	60%
	Automation of industrial systems	3	2	1h30		1h30	37h30	37h30	40%	60%
	Advanced Python programming	2	2	1h30		1h30	45h00	55h00	40%	60%
Discovery Unit Code: EU 1.1 Credits: 1 Coeff: 1	Subject of choice	1	1	1h30			22h30	02h30		100%
Total semester 1		**30**	**17**	**13h30**	**6h00**	**6h00**	**382h30**			

Semester 2: Mechanical Construction

Teaching Unit	Subjects Title	Cred.	Coef.	Weekly Vol. Lec.	Tut	Lab	SCH (15 w)	Comp. Work	Evaluation CA	Exam
Fundamental Unit Code: CU 1.2.1 Credits: 10 Coeff: 5	Finite element method	6	3	3h00	1h30		67h30	82h30	40%	60%
	Advanced structural dynamics	4	2	1h30	1h30		45h00	55h00	40%	60%
Fundamental Unit Code: CU 1.2.2 Credits: 8 Coeff: 4	Articulated mechanical systems and robotics	4	2	1h30	1h30		45h00	55h00	40%	60%
	Mechanical systems design	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological Unit Code: MU 1.2 Credits: 9 Coeff: 5	Lab Finite element method	2	1			1h30	22h30	27h30	100%	
	CAD/CAM	3	2	1h30		1h30	37h30	37h30	40%	60%
	Optimization	4	2	1h30		1h30	45h00	55h00	40%	60%
Transversal Unit Code: TU 1.2 Credits: 3 Coeff: 3	Respect for standards and rules of ethics and integrity	1	1	1h30			22h30	02h30		100%
	Elements of applied AI	2	2	1h30	1h30		45h00	5h00	40%	60%
Total semester 2		**30**	**17**	**15h00**	**6h00**	**4h30**	**382h30**			

Semester 3: Mechanical Construction

Teaching Unit	Subjects Title	Cred.	Coef.	Weekly Vol.			SCH (15 w)	Comp. Work	Evaluation	
				Lec.	Tut	Lab			CA	Exam
Fundamental Unit Code: CU 2.1.1 Credits: 10 Coeff: 5	Materials	4	2	1h30	1h30		45h00	55h00	40%	60%
	Dynamics of rotating machines	4	2	1h30	1h30		45h00	55h00	40%	60%
	Steel framework	2	1	1h30			22h30	27h30		100%
Fundamental Unit Code: CU 2.1.2 Credits: 8 Coeff: 4	Composite materials	4	2	1h30	1h30		45h00	55h00	40%	60%
	Fracture mechanics and fatigue	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological Unit Code: MU 2.1 Credits: 9 Coeff: 5	Methods Department	4	2	1h30		1h30	45h00	55h00	40%	60%
	Turbomachinery	3	2	1h30		1h30	37h30	37h30	40%	60%
	Numerical simulation software in mechanics	2	1			1h30	22h30	27h30	100%	
Transversal Unit Code: TU 2.1 Credits: 3 Coeff: 3	Reverse engineering	2	2	1h30	1h30	Workshop	45h00	05h00	40%	60%
	Documentary research and thesis design	1	1	1h30			22h30	02h30		100%
Total semester 3		**30**	**17**	**13h30**	**6h00**	**6h00**	**382h30**			

Discovery Units (EU) (S1, S2, S3)

- Tribology (*)

- Renewable energies (*)

- Hygiene and safety

- Aeronautics

- Transport

- Reliability

- Quality management

- Collaborative Design (*)

- Theory of inventive problem solving "TRIZ Method" (*)

- Mechanisms of motion transformation and Cams (*)

- Hydraulic and pneumatic systems and devices (*)

- Welding techniques (*)

- Non-destructive testing (*)

- Electronics

- Electrotechnics

(*) Recommended EU

Semester 4: Mechanical Construction

This semester is devoted to the realization of the master's end-of-cycle project. It culminates in a thesis and an oral defense.

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

Evaluation of the Master's End-of-Cycle Project

- Scientific value (Jury assessment) /6

- Thesis writing (Jury assessment) /4

- Presentation and answering questions (Jury assessment) /4

- Supervisor's assessment /3

- Internship report presentation (Jury assessment) /3

III - Detailed Program by Subject for Semester S1

Continuum Mechanics

Semester: 1
Teaching Unit: CU 1.1.1
SCH: 67 h30 (Lecture: 3h00, Tut: 1h30)

Credits: 6
Coefficient: 3

Teaching objectives: Master theoretical foundations of solid body transformations and indicial notation.

Recommended prior knowledge: Rational Mechanics, Mathematical Analysis.

Content of the subject:

- **Chapter 1: Introduction to continuum mechanics (1 week)**

- **Chapter 2: Tensor calculus and indicial notation (2 weeks)**

- **Chapter 3: Strain tensor (2 weeks)**

- **Chapter 4: Stress tensor (3 weeks)**

- **Chapter 5: Constitutive laws in linear elasticity (2 weeks)**

- **Chapter 6: Strain energy and failure criteria (1 week)**

- **Chapter 7: Resolution of linear elasticity problems (4 weeks)**

Evaluation Method: Continuous assessment: 40%; exam: 60%.

Bibliographical references:

- Mécanique des milieux continus - Tome 1 - Concepts généraux par Jean Salençon, Edition Ecole Polytechnique de Paris, (2005).

- Mécanique des milieux continus - Tome 2 - Thermoélasticité par Jean Salençon, Edition Ecole Polytechnique de Paris, (2002).

- Mécanique des milieux continus - Tome 3 - Milieux curvilignes par Jean Salençon, Edition Ecole Polytechnique de Paris, (2002).

- Mécanique des milieux continus, par P. Germain, Editions Masson, Paris (1983)

- Théorie de l'élasticité, par S. Timoshenko et J.M.Goodier, Librairie Polytechnique Ch. Béranger, 1961

- Mécanique des milieux continus - 4e édition: Cours et exercices corrigés, par Jean Coirier et Carole Nadot-Martin, Edition Dunod, 2013

- Modélisation mathématique et mécanique des milieux continus, Par Roger Temam et Alain Miranville, Edition Scopos, Springer.

- Mécanique des milieux continus, par G. Duvaut, Edition Masson, 1990

- Introduction à la mécanique des milieux continus, par Paul Germain et Patrick Muller, Edition Masson, 1995

- Mécanique des milieux continus: une introduction, Par John Botsis et Michel Deville, Presses Polytechniques et Universitaires Romandes

Advanced strength of materials

Semester: 1
Teaching Unit: CU 1.1.1
SCH: 45h (Lecture: 01h30, Tut: 01h30)

Credits: 4
Coefficient: 2

Teaching objectives: Master analytical calculation of beams under complex stresses and instability study.

Recommended prior knowledge: Basic Strength of Materials, Continuum Mechanics.

Content of the subject:

- **Chapter 1: Review on stress calculation in case of unsymmetrical bending (2 weeks)**

- **Chapter 2: Study of beam instability (Buckling of beams) (3 weeks)**

- **Chapter 3: Resolution of hyperstatic systems by the force method (3 weeks)**

- **Chapter 4: Limit stress state theories (2 weeks)**

- **Chapter 5: Thin plates and shells (2 weeks)**

- **Chapter 6: Calculation of elements beyond the elastic limit (2 weeks)**

- **Chapter 7: Resistance during cyclic stresses (1 week)**

Evaluation Method: Continuous Assessment: 40%; Exam: 60%.

Bibliographical references:

- Résistance des matériaux, V. Feodossiev Edition MIR 1971.

- Résistance des matériaux, William A. Nash ; McGraw-Hill 1983.

- A. Giet ; L. Geminard. « Résistance des matériaux », Editions Dunod 1986, Paris.

- M. Albiges ; A Coin. « Résistance des matériaux », Editions Eyrolles 1986 ; Paris.

- Jean-Claude Doubrère. « Résistance des matériaux », Editions Eyrolles 2013

- YoudeXiong. « Exercices résolus de résistance des matériaux », Editions Eyrolles, 2014.

- Claude Chèze. « Résistance des matériaux - Dimensionnement des structures, Sollicitations simples et composées, flambage, énergie interne, systèmes hyperstatiques », Ellipses, 2012.

- Résistance des matériaux, P. STEPINE, Editions MIR ; Moscou, 1986.

- Montagner R., Cours de résistance des matériaux, 12eme Edition 1988, Editions Eyrolles.

- Timoshenko S. Résistance des matériaux – Tome 1: Théorie élémentaire et problèmes. 3ème Ed. Dunod, Paris, 1968, 420p.

- Timoshenko S. Résistance des matériaux–Tome 2: Théorie développée et problèmes, Dunod, Paris, 1968. 3ème Ed. Dunod, Paris, 1968, 464p.

- N. Bourahla, résistance des matériaux de base, GECOTEC, 2013 .

Internal combustion engines

Semester: 1
Teaching Unit: CU 1.1.2
SCH: 45h (Lecture: 01h30, Tut: 1h30)

Credits: 4
Coefficient: 2

Teaching objectives: Understanding the operation and sizing of thermal engines and their environmental impact.

Recommended prior knowledge: Thermodynamics, Fluid Mechanics.

Content of the subject:

- **Chapter 1: Main kinematic chain and functional auxiliaries (3 weeks)**

- **Chapter 2: New techniques and engine efficiency improvement (2 weeks)**

- **Chapter 3: Breathing: operating modes, aspiration and supercharging (2 weeks)**

- **Chapter 4: Friction, general architecture, main dimensions (2 weeks)**

- **Chapter 5: Combustibility properties and study of combustion modes (2 weeks)**

- **Chapter 6: Study of anomalies and optimization of combustion laws (2 weeks)**

- **Chapter 7: Fueling technologies and control of polluting emissions (2 weeks)**

Evaluation Method: Continuous Assessment: 40%; Exam: 60%.

Bibliographical references:

- J. B. Heywood, "Internal Combustion Fundamentals", McGraw Hill Higher Education, 1989.

- P. Arquès, « Conception et construction des moteurs alternatifs :De la théorie à la compétition », Ellipse, 2000.

- J-C. Guibet, « Carburants et moteurs », 1997.

- P. Arquès, « Moteurs alternatifs à combustion interne (Technologie) », Masson édition, 1987.

- U.Y. FaminGorban, A.I., Dobrovolsky V.V, Lukin A.I. et al., « Moteurs marins à combustion interne », Leningrad:Sudostrojenij, 1989, 344p.

- W. Diamant, « Moteurs à combustion interne », ECAM, 1984.

- M. Desbois, R. Armao, « Le moteur diesel, Edition Foucher », Paris, 1974.

- M. Menardon, D. Jolivet, « Les moteurs, Edition Chotard », Paris, 1986.

- M. Desbois, « L'automobile : T1 : les moteurs à 4 temps et à deux temps. T2 : Les organes de transmission et d'utilisation », Edition Chotard, 1989.

- P. Arques, « La combustion », Ellipses, Paris, 1987.

- H. Memetau, « Techniques fonctionnelles de l'automobile : Le Moteur et ses auxiliaires », Dunod, Paris, 2002.

- Allan T. Kirkpatrick, « Internal Combustion Engines- Applied Thermosciences », Third edition, Fourth edition, Wiley, 2021.

- Colin R. Ferguson, Allan T. Kirkpatrick, « Internal Combustion Engines- Applied Thermosciences », Third edition, Wiley, 2016.

- A. Bechkok, « Les moteurs à combustion interne : A l'usage des étudiants en 4 ème année du Génie Mécanique », Edition Office des publications universitaires, Alger, 1995.

- Willard W. Pulkrabek, « Engineering Fundamentals of the internal combustion engine », Second edition, Prentice Hall, 2003.

- Willard W. Pulkrabek, «Solutions Manual for Engineering Fundamentals of the Internal Combustion Engine», Second edition, Prentice Hall, 2003.

- J.-C. Guibet, « Carburants et moteurs : Technologies, Energie, Environnement », Tome 1, Technip, 1997.

Applied fluid mechanics

Semester: 1
Teaching Unit: CU 1.1.2
SCH: 45h (Lecture: 01h30, Tut: 01h30)

Credits: 4
Coefficient: 2

Teaching objectives: Mastering flow calculations in networks and lubrication concepts.

Recommended prior knowledge: General Fluid Mechanics.

Content of the subject:

- **Chapter 1: Review of Fluid Statics (1 week)**

- **Chapter 2: Concept of Fluid Dynamics (1 week)**

- **Chapter 3: Flow regimes of primary and secondary fluids (2 weeks)**

- **Chapter 4: Application of conservation laws (3 weeks)**

- **Chapter 5: Flow in pipes (FANNO and RAYLEIGH) (3 weeks)**

- **Chapter 6: Calculation of distribution networks (3 weeks)**

- **Chapter 8: Hydrodynamic lubrication (2 weeks)**

Evaluation Method: Continuous Assessment: 40%; Exam: 60%.

Bibliographical references:

- Thermohydraulique multiphasique, document de cours, G. BERTHOUD, ENSPG – France, 1993.

- Boiling condensation and gas –liquid flow, P. B. WHALLEY, Oxford, 1987.

- Multiphase Flow Dynamics, Kaviany, Maasoud, 1- Fundamentals.

- Multiphase Flow Dynamics,Kaviany, M., 2- Thermal and Mechanical Interactions.

Lab FM/MoM

Semester: 1
Teaching Unit: MU 1.1
SCH: 22h30 (Lab: 01h30)

Credits: 2
Coefficient: 1

Teaching objectives: Verification of theoretical laws through experimentation.

Recommended prior knowledge: Basic FM and MoM.

Practical work:

- **Fluid Mechanics Lab:**

  - **Lab 01:** Flow measurement and viscosity.
  - **Lab 02:** Study of the Center of Pressure.
  - **Lab 03:** Fluid Statics.
  - **Lab 04:** Flow around an obstacle.
  - **Lab 05:** Jet impulse.
  - **Lab 06:** Head losses and velocity profiles.
  - **Lab 07:** Influence of the pressure field on a hydrodynamic bearing.
  - **Lab 08:** Effect of the inclination of a plane pad on the pressure distribution.

- **Strength of Materials Lab:**

  - **Lab 01:** Trussed beam.
  - **Lab 02:** Transverse displacements - Bending.
  - **Lab 03:** Bending moments & Normal stresses - Bending.
  - **Lab 04:** Buckling.
  - **Lab 05:** Hyperstatic systems.

Evaluation Method: Continuous Assessment: 100%.

Bibliographical references:

Conventional and advanced manufacturing techniques

Semester: 1
Teaching Unit: MU 1.1
SCH: 45h (Lecture: 01h30, Lab: 01h30)

Credits: 4
Coefficient: 2

Teaching objectives: Mastering advanced product design and manufacturing methods.

Recommended prior knowledge: Workshop technology.

Content of the subject:

- **Part I: Conventional manufacturing processes (7 weeks)**

  - Introduction.
  - Foundry.
  - Plastic deformation.
  - Flat product forming.
  - Machining.

- **Part II: Advanced manufacturing processes (8 weeks)**

  - Electro-Discharge Machining (EDM).
  - Sintering.
  - Photochemical machining.
  - Laser machining.
  - Explosive forming.
  - Electro-hydraulic forming.
  - Electromagnetic forming.

Practical work:

- **Lab 1:** Foundry.

- **Lab 2:** Machining (Turning, Milling).

- **Lab 3:** Plastic deformation.

- **Lab 4:** Welding.

Evaluation Method: Continuous Assessment: 40%; Exam: 60%.

Bibliographical references:

- Claude Corbet, Mémotech - Procédés de mise en forme des matériaux, Editeur(s) : Casteilla, Collection : Mémotech, 2005.

- M. Ashby, Y. Bréchet, L. Salvo, selection des materiaux et des procedes d e mise en œuvre, Vol. 20 du Traité des Matériaux, Presses polytechniques et universitairesromandes, 2001.

- Eric FELDER, Mise en forme des métaux - Aspects mécaniques et thermiques, Techniques de l'Ingénieur, Référence M3000 v2, 2015.

- Éric FELDER, Lubrification en mise en forme - Principes généraux et choix, Techniques de l'Ingénieur, Référence M3015 v1, 2006.

- SUÉRY Michel, Mise en forme des alliages métalliques à l'état semi-solide, Hermes, Lavoisier, 2002.

- Battaglia Jean-Luc, Transferts thermiques dans les procédés de mise en forme des matériaux :cours et exercices corrigés, Paris Hermes science publ. 2007 Lavoisier.

- L. Rimbaud, G. Layes, J. Moulin, Guide Pratique de l'usinage, Hachette Technique, 2006.

- J. SAINT-CHELY, "choix des outils et des conditions de coupe en tournage", 1993.

- Pierre Bourdet. La coupe des métaux. Cours Ecole normale supérieure de Cachan, Ver 5 2004

- J. Jacob, Y. Malesson, D. Ricque, Guide pratique de l'usinage 2 : Tournage, Hachette Techniques.

- François BAGUR, Matériaux pour outils de coupe, Techniques de l'Ingénieur, Référence BM7080 v1, 1999.

- Eric FELDER, Modélisation de la coupe des métaux, Techniques de l'Ingénieur, Référence BM7041 v1, 2006.

Automation of industrial systems

Semester: 1
Teaching Unit: MU 1.1
SCH: 37h30 (Lecture: 01h30, Lab: 01h30)

Credits: 3
Coefficient: 2

Teaching objectives: Understanding industrial control and supervision systems.

Recommended prior knowledge: General electronics.

Content of the subject:

- **Chapter 1: Introduction, control systems, supervisory systems, MES (2 weeks)**

- **Chapter 2: Automated systems (Industrial control and command) (3 weeks)**

- **Chapter 3: Supervisory systems (4 weeks)**

- **Chapter 4: Structure of programmable logic controllers (4 weeks)**

- **Chapter 5: Industrial interfaces and safety devices (2 weeks)**

Evaluation Method: Continuous Assessment: 40%; Exam: 60%.

Bibliographical references:

- Henri Bourles. « Systèmes linéaires de la modélisation à la commande ». Editions Lavoisier 2006, Paris.

- Jean Marie Flans. « La régulation industrielle ». Hermès 1994 ; Paris.

- Philippe de Larminat. « Automatique commande des systèmes linéaires ». Editions Hermès 1996 ; Paris

- Patrick Prouvost. « Automatique – Contrôle et régulation », Edition Dunod 2010.

- Yves GRANJON. « Automatique ». Edition Dunod 2010

- Olivier Le Gallo. « Automatique des systèmes mécaniques ». Edition Dunod, 2009.

- Gérard Boujat, Patrick Anaya. « Automatique industrielle », Edition Dunod, 2007.

- JANET Maurice. « Précis de calcul matriciel et de calcul opérationnel », Edition Euclide 1982.

- Patrick Prouvost. « Automatique – Contrôle et régulation ». Edition Dunod, 2010.

Advanced Python Programming

Semester: 1
Teaching Unit: MU 1.1
SCH: 45h00 (Lecture 1h30, Lab 1h30)

Credits: 2
Coefficient: 2

Teaching objectives: Development of specific scripts for engineering tasks and resource management.

Recommended prior knowledge: Basic algorithmics.

Content of the subject:

- **Chapter 1: Review of Python programming (2 weeks)**

  - Introduction: Basic concepts in computer science and digital tools, Python installation.
  - Presentation of the operating system concept: Roles, types (Linux, Windows, etc.), priority management.
  - Presentation of computer networks (Principle, IP address, DNS, internet, etc.).
  - Basic programming: Interactive mode and script mode, Variables, data types, operators. Conditional structures and loops (if, for, while).
  - Functions and essential elements: Predefined functions and creation of functions. Standard modules (math, random). Strings, lists, basic data manipulation.
  - Files, Lists, Tuples, Dictionaries.
  - Exercises: Python learning exercises, use of libraries seen in class (Math, Random, NumPy, Pandas, etc.).

- **Chapter 2: Programming and task automation (4 weeks)**

  - 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 examples of automation (sending emails, etc.).
  - File manipulation with Python: Using libraries to browse a folder (os.listdir), check existence of a file/folder (os.path.exists), create or delete folders (os.mkdir, os.rmdir).
  - Visualizing data: Matplotlib, Seaborn, Plotly.
  - Request to react with Application Programming Interfaces (API).
  - Beautiful Soup for data scraping.
  - Tkinter, PyQt to visualize graphical data.
  - Copy or move files with shutil.
  - Search, sort and generation of simple reports.
  - Serialization and Deserialization (Using the pickle module).
  - Object serialization and large file processing (streaming).
  - 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 (search, sort), automate technical calculations, manage simple reports (PDF, Excel). Search, sort, and insertion sort algorithms. Implement a search function in a list. File operations. Secure browsing (simple network configuration, password management).

- **Chapter 3: Advanced learning of Excel (2 weeks)**

  - Principles of macros and creation of a simple macro.
  - Pivot tables.
  - Histograms, Bar charts, Spider charts, etc.
  - Excel Exercises.

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

- Introduction to project management: What is a project? What are the challenges of project management?
- GanttProject interface.
- Tasks (creation, modification, organization).
- Time management (project start or end dates).
- Resource management.
- GanttProject Exercises.

- **Chapter 5: Advanced object-oriented programming (3 weeks)**

  - Code organization: Custom functions, parameters, return value. Modules, imports, and packages.
  - Complex data structures: Lists, tuples, and dictionaries (creation, modification, deletion, traversal).
  - Fundamental concepts of Object-Oriented Programming (OOP): Classes, objects, attributes, and methods. Public, private, and protected attributes. Special methods: init, str, repr, len.
  - Advanced concepts: Encapsulation, abstraction, inheritance, polymorphism. Advanced inheritance, decorators, design patterns, metaclasses.
  - Exercises.

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

  - Introduction to common AI Datasets: Iris, MNIST, CIFAR-10, Boston Housing, ImageNet.
  - Data preprocessing for Machine Learning: Cleaning, normalization, encoding, data splitting. Cross-validation.
  - Feature Engineering Techniques: Selection, feature creation, dimensionality reduction.
  - Essential libraries for AI model development: scikit-learn, TensorFlow, Keras, PyTorch.
  - Exercises.

Practical work:

- **Lab 1: Master basics of Python programming:** Control structures, types, loops, simple functions. Initiation, Read and process text files, Manage simple reports (PDF, Excel).

- **Lab 2: Task automation mini-project specifications:** Identify and automatically send reports by email with Python: Load data from a file, perform simple statistics, generate a graph, send the result with Python.

- **Lab 3: Excel dashboard programming:** Creation of automated Excel tables, Simple macros, Conditional formulas, VLOOKUP.

- **Lab 4: Organize a meeting in GanttProject:** Create a new project, define tasks (agenda points, sub-tasks), define resources (participants, equipment), estimate durations, create and visualize the Gantt chart.

- **Lab 5: Advanced structures and code organization:** Custom functions, dictionaries, modules, and modular organization.

- **Lab 6: Advanced OOP in Python:** Encapsulation, inheritance, special methods, simple design patterns.

- **Lab 7: File manipulation and data analysis:** File reading/writing, text processing, introduction to Pandas and NumPy.

- **Lab 8: Data preparation and processing for AI:** Loading AI datasets, cleaning, transformation, feature selection.

- **Final Project:** Analysis and visualization of a dataset + simple predictive model. Mobilized skills: Data reading, OOP, advanced structures, Pandas, Scikit-learn (Oral presentation + written report).

Evaluation Method: Continuous Assessment: 40%; Exam: 60%.

Bibliographical references:

- E.Schultz et M.Bussonnier (2020) : Python pour les SHS. Introduction à la programmation de données. Presses Universitaires de Rennes.

- C.Paroissin, (2021) : Pratique de la data science avec R : arranger, visualiser, analyser et présenter des données. Paris : Ellipses, DL 2021.

- S.Balech et C.Benavent : NLP texte minig V4.0, (Paris Dauphine – 12/2019) : lien : https://www.research-gate.net/publication/337744581_NLP_text_mining_V40_-_une_introduction_-_cours_programme_doctoral

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

- Ramalho, L.. Fluent Python. " O'Reilly Media, Inc.", 2022;

- Swinnen, G.. Apprendre à programmer avec Python 3. Editions Eyrolles, 2012;

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

- Cyrille, H. (2018). Apprendre à programmer avec Python 3. Eyrolles, 6ème édition. ISBN: 978-2212675214

- Daniel, I. (2024). Apprendre à coder en Python, J'ai lu

- Nicolas, B. (2024). Python, du grand débutant à la programmation objet Cours et exercices corrigés, 3eme édition, Ellipses

- Ludivine, C. (2024). Selenium Maîtrisez vos tests fonctionnels avec Python, Eni

- Ressources en ligne : Documentation officielle Python : docs.python.org, Exercices Python sur Codecademy : codecademy.com/learn/learn-python-3, W3Schools Python Tutorial : w3schools.com/python/

Subject of choice

Semester: 1
Teaching Unit: EU 1.1
SCH: 22h30 (Lecture: 1h30)

Credits: 1
Coefficient: 1

IV - Detailed Program by Subject for Semester S2

Finite element method

Semester: 2
Teaching Unit: CU 1.2.1
SCH: 67h30 (Lecture : 3h00, Tut : 1h30)

Credits: 6
Coefficient: 3

Teaching objectives: Understanding and implementation of FEM for linear structural analysis.

Recommended prior knowledge: MoM, Matrix calculation.

Content of the subject:

- **Chapter 1: Basic Concepts (2 weeks)**

- **Chapter 2: Linear structural elements (4 weeks)**

- **Chapter 3: Two-dimensional structural elements (3 weeks)**

- **Chapter 4: Three-dimensional structural elements (3 weeks)**

- **Chapter 6: Complementary formulations (Mesh design, Convergence, Material non-linearity, Thermal problems) (3 weeks)**

Evaluation Method: Continuous Assessment: 40%; Exam: 60%.

Bibliographical references:

- J.F. Imbert, "Analyse Des Structures Par Elements Finis", Cepadues, 3ème Éd., 1991.

- Jean-Louis Batoz, Gouri Dhatt, "Modelisation Des Structures Par Elements Finis, Volume 1 : Solides Elastiques", Hermès Sciences Publication 1990.

- Jean-Louis Batoz, Gouri Dhatt, "Modelisation Des Structures Par Elements Finis, Volume 2 : Poutres & Plaques", Hermès Sciences Publication 1990.

- Jean-Louis Batoz, "Modelisation Des Structures Par Elements Finis, Tome 3 : Coques", Hermès Sciences Publication 1992.

- O.C.Zienkiewicz, "La Methode Des Elements Finis", Mc Graw Hill, 1979.

- Comprendre les éléments finis (Principes, formulation et exercices corrigés)

- Rahmani O et Kebdani S., Introduction à la méthode des éléments finis pour les ingénieurs, 2èmeed. OPU, 1994.

- Paul Louis George, "Generation Automatique De Maillages: Applications Aux Methodes d'elements Finis", Dunod, 1990.

- C. ZienkiewiczAnd R. L. Taylor, "The Finite Element Method For Solid And Structural Mechanics", Sixth Edition By O. Butterworth-Heinemann 2005.

- AlaaChateauneuf, "Comprendre Les Elements Finis : Structures. Principes, Formulations Et Exercices Corriges", Ellipses Marketing, Juillet 2005.

Advanced structural dynamics

Semester: 2
Teaching Unit: CU 1.2.1
SCH: 45h00 (Lecture : 1h30, Tut : 1h30)

Credits: 4
Coefficient: 2

Teaching objectives: Mastering the study of structures under dynamic loading.

Recommended prior knowledge: General mechanics, Vibrations.

Content of the subject:

- **Chapter 1: Review of kinetics and Fundamental Principles (2 weeks)**

- **Chapter 2: Single degree of freedom systems (2 weeks)**

- **Chapter 3: Forced oscillations and harmonic loading (2 weeks)**

- **Chapter 4: Vibrations of continuous systems (strings, beams) (3 weeks)**

- **Chapter 5: Variational methods for eigenvalues (3 weeks)**

- **Chapter 6: Numerical methods applied to structural dynamics (3 weeks)**

Evaluation Method: Continuous Assessment: 40%; Exam: 60%.

Bibliographical references:

- Théorie Des Vibrations, S. Timoshnko.

- Théorie Des Vibrations, Application à la dynamique des structures, M. Géradin.

- Dynamique des structures Patrick PaultreHermès - Lavoisier.

- Dynamique des structures : Analyse modale numérique deThomas Gmür Editeur : Presses Polytechniques et Universitaires Romandes.

- Dynamique des structures, Tome 1,Principes et fondamentaux, R.W.CLOUGH et J. PENZIEN.

- Dynamique des structures : Analyse modale numérique, Thomas Gmür , Editeur : Presses Polytechniques et Universitaires Romandes.

Articulated mechanical systems and robotics

Semester: 2
Teaching Unit: CU 1.2.2
SCH: 45h (Lecture: 01h30, Tut : 1h30)

Credits: 4
Coefficient: 2

Teaching objectives: Kinematic and dynamic modeling of manipulators and mobile systems.

Recommended prior knowledge: Matrix mechanics.

Content of the subject:

- **Chapter 1: Introduction to robotics architectures (1 week)**

- **Chapter 2: Parameterization of a chain of solids (2 weeks)**

- **Chapter 3: Direct and inverse geometric models (3 weeks)**

- **Chapter 4: Direct and inverse kinematic models (2 weeks)**

- **Chapter 5: Dynamic modeling (Newton-Euler) (3 weeks)**

- **Chapter 6: Motion generation and path planning (2 weeks)**

- **Chapter 7: Medical robotics and mobility assistance (2 weeks)**

Practical work:

- **Mini-project:** Modeling a robot for a specific task, workspace determination, and optimal placement.

- **OR Lab:** Robot programming (point-to-point tasks, continuous tasks, pick and place).

Evaluation Method: Continuous Assessment: 40%; Exam: 60%.

Bibliographical references:

- Modélisation, identification et commande des robots, Wisama Khalil et Etienne Dombre ; Herrmes Lavoisier 1999.

- Théorie des mécanismesparfaits : outils de conception auteur(s) : leroyLavoisier 1998.

- Théorie simplifiée des mécanismes élémentaires auteur : loche l.-e. Dunod 2001.

- J. P. Lellmendet SaidZeghloul " Robotique aspects fondamentaux Masson1991.

- Théorie des mécanismes parfaits : outils de conception auteur(s) : leroyLavoisier 1998.

- A. Pruski Robotique générale. Ellipses 1988.

- P. André Traité de robotique T4 : Constituants technologiques. Hermes 1986.

- M. Cazin et J. Metje Mécanique de la robotique Dunod1989.

- Jack Guittet La robotique médicale. Hermes1998.

- Saeed Benjamin Niku, « Introductionto robotics - analysis, control, applications», second edition, Wiley, 2011.

- John J. Craig , « Introduction to Robotics – Mechanics and control », Pearson, 2005.

- Reza N. lazar , « Theory of AppliedRobotics - Kinematics, Dynamics, and Control »,Library of Congress, 2007.

Mechanical systems design

Semester: 2
Teaching Unit: CU 1.2.2
SCH: 45h (Lecture : 01h30, Tut: 01h30)

Credits: 4
Coefficient: 2

Teaching objectives: Understanding technical certification and design of complex mechanisms.

Recommended prior knowledge: Technical drawing, Kinematics.

Content of the subject:

- **Chapter 1: Quality approach and certification (1 week)**

- **Chapter 2: Functional specifications drafting (2 weeks)**

- **Chapter 3: Functional analysis approach and value engineering (3 weeks)**

- **Chapter 4: Applications to vehicle and lifting mechanisms (4 weeks)**

- **Chapter 5: Computer-Aided Mechanical Design (CAMD) and power transmission (5 weeks)**

Evaluation Method: Continuous Assessment: 40%; Exam: 60%.

Bibliographical references:

- Alain Pouget, Thierry Berthomieu , Yves Boutron, Emmanuel Cuenot, « Structures et mécanismes - Activités de construction mécanique », Ed. Hachette Technique.

- Yousef Haik, Tamer Shahin, "Engineering Design Process", Ed. Engage Learning, 2011.

- KEN HURST, "Engineering Design Principles", Ed. Elsevier Science and Technology Books, 1999.

- JAMES ARMSTRONG , "Design Matter -The Organisation and Principles of EngineeringDesign-", Ed. Springer -Verlag London Limited, 2008.

- DELAFOLLIE G., "Analyse de la valeur", Ed. Hachette, Paris, 1991.

- DUCHAMP F., "La conception de produits nouveaux", Ed. Hermès, Paris, 1998.

- ROBERT C. JUVINALL, KURT M. MARSHEK , "Fundamentals of Machine ComponentDesign", Ed. John Wiley Sons, 2012.

- GEORGES SPINNLER , "Conception des machines -Principes et applications-", T1, T2 et T3, Ed. Presses polytechniques et universitaires romandes, 2002.

- ROBERT L. NORTON , "Machine Design -An Integrated Approach-", Ed. PEARSON Prentice Hall, 2006.

- R. Quatremer, J-P Trotignon, M. Dejans, H. Lehu, « Précis de Construction Mécanique », Tome 1, Projets-études, composants, normalisation, Afnor, Nathan 2001.

- R. Quatremer, J-P Trotignon, M. Dejans, H. Lehu. « Précis de Construction Mécanique », Tome 3, Projets-calculs, dimensionnement, normalisation, Afnor, Nathan 1997.

- Francis Esnault, « Construction mécanique, Transmission de puissance », Tome 1, Principes et Ecoconception, Dunod, 2009.

- Francis Esnault, « Construction mécanique, Transmission de puissance », Tome 2, Applications, Dunod, 2001.

- Francis Esnault, « Construction mécanique, Transmission de puissance », Tome 3, Transmission de puissance par liens flexibles, Dunod, 1999.

- M. Szwarcman, « Eléments de machines », édition Lavoisier 1983W. L. Cleghorn, "Mechanics of machines", Oxford University Press, 2008.

Lab Finite elements

Semester: 2
Teaching Unit: MU 1.2
SCH: 22h30 (Lab : 01h30)

Credits: 2
Coefficient: 1

Teaching objectives: Mastery of finite element simulation software.

Recommended prior knowledge: Numerical analysis.

Practical work:

- **Lab 1:** Springs, bars, and beam elements.

- **Lab 2:** 2D planar elements (Analytical formulation of Q4, T3 and software modeling, comparing with analytical solutions).

- **Lab 3:** Axisymmetric elements (internal pressure cylinder).

- **Lab 4:** Vibration of beams and plates using membrane and plate elements.

- **Lab 5:** Heat transfer simulation.

- **Lab 6:** Plastic calculation of 2D and 3D structures.

- **Lab 7:** Fortran or Matlab programming of Q4, T3, Bar and Beam elements.

Evaluation Method: Continuous Assessment: 100%.

Bibliographical references:

- J.F. Imbert, "Analyse Des Structures Par Elements Finis", Cepadues, 3ème Éd., 1991.

- Jean-Louis Batoz, Gouri Dhatt, "Modélisation Des Structures Par Eléments Finis, Volume 1 : Solides Elastiques", Hermès Sciences Publication 1990.

- Jean-Louis Batoz, Gouri Dhatt, "Modélisation Des Structures Par Eléments Finis, Volume 2 : Poutres & Plaques", Hermès Sciences Publication 1990.

- Jean-Louis Batoz, "Modélisation Des Structures Par Eléments Finis, Tome 3 : Coques", Hermès Sciences Publication 1992.

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- Comprendre les éléments finis (Principes, formulation et exercices corrigés)

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- D. Ouinas « Application de la méthode des éléments finis à l'usage des ingénieurs, cours et exercices corrigés ». Tome 1-OPU 2012.

- Paul Louis George, "Génération Automatique De Maillages: Applications Aux Méthodesd'éléments Finis", Dunod, 1990.

- C. Zienkiewiczand R. L. Taylor, "The Finite Element Method for Solid and Structural Mechanics", Sixth Edition by O. Butterworth-Heinemann 2005.

- AlaaChateauneuf, "Comprendre Les Eléments Finis : Structures. Principes, Formulations Et Exercices Corriges", Ellipses Marketing, Juillet 2005.

CAD/CAM

Semester: 2
Teaching Unit: MU 1.2
SCH: 37h30 (Lecture 1h30, Lab : 1h00)

Credits: 3
Coefficient: 2

Teaching objectives: Practical use of CAD/CAM systems for digital manufacturing.

Recommended prior knowledge: CAD basics.

Content of the subject:

- **Chapter 1: Generalities (System and curve/surface modeling) (3 weeks)**

- **Chapter 2: NC Machine Tools (MOCN) (1 week)**

- **Chapter 3: MOCN Programming (5 weeks)**

- **Chapter 4: CAM Software (4 weeks)**

- **Chapter 5: Basics of rapid prototyping and 3D printing (2 weeks)**

Practical work:

- **CAD Part (3 weeks):** Realization of complex shaped parts, assembly, drafting, and static simulation.

- **CAM Part (9 weeks):** Process planning, machine/reference/blank selection, operations, tool paths, simulation, G-code generation, verification, and machine transmission.

Evaluation Method: Continuous Assessment: 40%; Exam: 60%.

Bibliographical references:

- JEAN-CLAUDE LEON, "Modélisation et construction de surfaces pour la CFAO", Ed. Hermès, Paris, 1991.

- GERALD FARIN, "Curves and Surfaces for CAGD", Ed. Academic Press, 2002.

- M. HOSAKA, "Modelling of Curves and Surfaces in CAD/CAM", Ed. Springer Verlag, 1992.

- DAVID F. ROGERS, "An Introduction to NURBS with Historical Perspective", Ed. Academic Press, 2001.

- KUNWOO LEE, "Principles of CAD/CAM/CAE systems", Ed. Addison Wesley, 1999.

- Ibrahim Zeid, "Mastering CAD/CAM", Ed. McGraw-Hill, 2004.

- MILTIADIS A. BOBOULOS, "CAD-CAM & Rapid Prototyping Application Evaluation", Ed. Ventus Publishing Aps, 2010.

- ALAIN BERNARD, "Fabrication assistée par ordinateur", Ed. Lavoisier Hermès-science, Paris, 2003.

- Peter Smid, "CNC Programming Handbook", Ed. IndustrialPress Inc., 2007.

- JEAN VERGNAS, "Exploitation des machines-outils à commande numérique", Ed. Pyc, 1985.

- CLAUDE HAZARD, "La commande numérique des machines-outils", Ed. Foucher, 1984.

- CLAUDE MARTY, CLAUDE CASSAGNES, PHILIPPE MARIN, "La pratique de la commande numérique des machines-outils", Ed. Tec & Doc, 1993.

- A. CORNAND, F. KOLB, "Usinage et commande numérique", Ed. Foucher, 1987.

- P. GONZALEZ, "La commande numérique par calculateur : tournage, fraisage, centred'usinage", Ed. Casteilla, Paris, 1993.

- Documentation du logiciel CATIA, "Catia Lathe Machining", "Catia Prismatic Machining", "Catia Advanced Machining".

Optimization

Semester: 2
Teaching Unit: MU 1.2
SCH: 45h00 (Lecture: 1h30, Lab:1h30)

Credits: 4
Coefficient: 2

Teaching objectives: Search for optimal sizing and technical parameters.

Recommended prior knowledge: Analysis and Algebra.

Content of the subject:

- **Chapter 1: Linear optimization (3 weeks)**

- **Chapter 2: Unconstrained non-linear optimization (5 weeks)**

- **Chapter 3: Constrained non-linear optimization (4 weeks)**

- **Chapter 4: Stochastic optimization methods (3 weeks)**

Practical work:

- **Lab 1:** Presentation of Matlab optimization functions.

- **Lab 2:** Presentation of the optimtool in Matlab.

- **Lab 3:** Definition and plotting of some optimization test functions.

- **Lab 4:** Unconstrained linear optimization.

- **Lab 5:** Constrained linear optimization.

- **Lab 6:** Unconstrained non-linear minimization.

- **Lab 7:** Unconstrained non-linear minimization with Gradient and Hessian.

- **Lab 8:** Non-linear minimization with equality constraints.

- **Lab 9:** Non-linear minimization with inequality constraints.

- **Lab 10:** Minimization with both equality and inequality constraints.

- **Lab 11:** Using optimtool or equivalent for constrained non-linear problems.

- **Lab 12:** Constrained minimization using the GA function.

Evaluation Method: Continuous Assessment: 40%; Exam: 60%.

Bibliographical references:

- E. Aarts& J. Korst, Simulated annealing and Boltzmann machines: A stochastic approach to combinatorial optimization and neural computing. John Wiley & Sons, New York, 1997.

- D. Bertsekas, Nonlinear programming. Athena Scientific, Belmont, MA, 1999.

- M. Bierlaire, Introduction à l'optimisation différentiable. Presses polytechniques et universitaires romandes, Lausanne, 2006.

- F. Bonnans, Optimisation continue : cours et problèmes corrigés. Dunod, Paris, 2006.

- F. Bonnans, J. C. Gilbert, C. Lemaréchal et C. Sagastizàbal, Optimisation numérique : aspects théoriques et pratiques. Springer, Berlin, 1997.

- P. G. Ciarlet, Introduction à l'analyse numérique matricielle et à l'optimisation. Masson, Paris, 1994.

- E. Chong et S. Zak, An introduction to optimisation. John Wiley & Sons, New York, 1995.

- Y. Colette et P. Siarry, Optimisation multiobjectif. Eyrolles, Paris, 2002.

- J. C. Culioli, Introduction à l'optimisation. Ellipses, Paris, 1994.

- J. Dennis & R. Schnabel, Numerical methods for unconstrained optimization and nonlinear equations. Prentice Hall, Englewood Cliffs, NJ, 1983.

- R. Fletcher, Practical methods of optimization. John Wiley & Sons, New York, 1987.

- P. Gill, W. Murray, & M. Wright, Practical optimization. Academic Press, New York, 1987.

Respect for standards and rules of ethics and integrity

Semester: 2

Teaching Unit: TU 1.2

SCH: 22h30 (Lecture: 1h30)

Credits: 1

Coefficient: 1

Teaching objectives: Raising awareness of professional ethics and scientific integrity rules.

Recommended prior knowledge: General Culture.

Content of the subject:

- **A. Respect for ethics and integrity rules**

  - **1. Principles of ethics and deontology:** Fundamental principles, MESRS ethics and deontology charter.
  - **2. Scientific integrity:** Definition, responsibilities.
  - **3. Plagiarism:** Definition, different forms, detection, sanctions.
  - **4. Scientific fraud:** Falsification, fabrication of data, conflict of interest.

- **B. Intellectual property**

  - **1. Introduction:** Definitions, fundamentals.
  - **2. Industrial property:** Patents, Trademarks, Industrial designs and models.
  - **3. Literary and artistic property:** Copyright, Neighboring rights.
  - **4. Protection bodies:** INAPI, ONDA, WIPO.

- **C. Ethics, sustainable development and new technologies**

  - Link between ethics and sustainable development, energy saving, bioethics and new technologies (artificial intelligence, scientific progress, Humanoids, Robots, drones).

Evaluation Method: Exam: 100%.

Bibliographical references:

- Charte d'éthique et de déontologie universitaires, https://www.mesrs.dz/documents/12221/26200/Charte+fran_ _ais+d__f.pdf/50d6de61-aabd-4829-84b3-8302b790bdce

- Arrêtés N°933 du 28 Juillet 2016 fixant les règles relatives à la prévention et la lutte contre le plagiat

- E. Prairat, De la déontologie enseignante. Paris, PUF, 2009.

- Racine L., Legault G. A., Bégin, L., Éthique et ingénierie, Montréal, McGraw Hill, 1991.

- Siroux, D., Déontologie : Dictionnaire d'éthique et de philosophie morale, Paris, Quadrige, 2004, p. 474-477.

- Medina Y., La déontologie, ce qui va changer dans l'entreprise, éditions d'Organisation, 2003.

- Didier Ch., Penser l'éthique des ingénieurs, Presses Universitaires de France, 2008.

- Gavarini L. et Ottavi D., Éditorial. de l'éthique professionnelle en formation et en recherche, Recherche et formation, 52 | 2006, 5-11.

- Caré C., Morale, éthique, déontologie. Administration et éducation, 2e trimestre 2002, n°94.

- Jacquet-Francillon, François. Notion : déontologie professionnelle. Letélémaque, mai 2000, n° 17

- Carr, D. Professionalism and Ethics in Teaching. New York, NY Routledge. 2000.

- Galloux, J.C., Droit de la propriété industrielle. Dalloz 2003.

- Wagret F. et J-M., Brevet d'invention, marques et propriété industrielle. PUF 2001

- Dekermadec, Y., Innover grâce au brevet : une révolution avec internet. Insep 1999

- AEUTBM. L'ingénieur au cœur de l'innovation. Université de technologie Belfort-Montbéliard

- http://www.app.asso.fr/

- http://ressources.univ-rennes2.fr/propriete-intellectuelle/cours-2-54.html

- Fanny Rinck et léda Mansour "littératie à l'ère du numérique : le copier-coller chez les étudiants" Université Grenoble 3 et Université paris ouest Nanterre la défense Nanterre, france

- L'abc du droit d'auteur, organisation des nations unies pour l'éducation, la science et la culture (UNESCO)

- Alain bensoussan livre blanc – une science ouverte dans une république numérique direction de l'information scientifique et technique CNRS

- Copyright in the cultural industries. - Cheltenham: E. Elgar, 2002. - XXII-263 p.

- Les logiciels de détection de similitudes : une solution au plagiat électronique ? Rapport du Groupe de travail sur le plagiat électronique présenté au Sous-comité sur la pédagogie et les TIC de la CREPUQ

- EmanuelaChiriac, Monique Filiatrault et André Régimbald. "guide de l'étudiant : l'intégrité intellectuelle plagiat, tricherie et fraude... les éviter et, surtout, comment bien citer ses sources" 2014

- Publication de l'université de montréal. « Stratégies de prévention du plagiat », Intégrité, fraude et plagiat, 2010

- Pierrick Malissard "La propriété intellectuelle "origine et évolution" 2010.

- Le site de l'Organisation Mondiale de la Propriété Intellectuelle www.wipo.int.

Elements of applied AI

Semester: 2

Teaching Unit: TU 1.2

SCH: 45h00 (Lecture 1h30, Lab 1h30)

Credits: 2

Coefficient: 2

Teaching objectives: Initiation to modern tools of artificial intelligence for engineering.

Recommended prior knowledge: Advanced programming.

Content of the subject:

- **Chapter 1: Introduction to artificial intelligence (AI) (1 week)**

  - Definitions and fields of application of AI. Historical evolution of AI.
  - Introduction to major fields: Machine Learning, Deep Learning.

- **Chapter 2: Basic mathematics for AI (1 week)**

  - Linear algebra: vectors, matrices, products, norms.
  - Probability & statistics: Variables, expectation, variance. Standard distributions: normal, binomial, uniform.
  - Simple linear regression: Formulation, cost, optimization. Implementation with Scikit-learn.
  - Exercises: Matrix manipulation with NumPy, Linear regression exercise with Scikit-learn, Matplotlib explanation.

- **Chapter 3: Machine Learning (3 weeks)**

  - Key concepts: Data, Models, features, labels, generalization.
  - Phases of a learning pipeline: training, validation, testing.
  - Types of learning: Supervised, Unsupervised, Reinforcement (overview).
  - Exercises: Deepening the concepts seen in class.

- **Chapter 4: Supervised classification (3 weeks)**

  - Principle of simple classification model training.
  - Models and algorithms: SVM (Support Vector Machine), Decision trees.
  - Performance evaluation: Confusion matrix, precision, recall, F1-score.
  - Exercises: How to use Scikit-learn, Comparison of several models on a dataset.

- **Chapter 5: Unsupervised learning**

  - Concept of clustering.
  - Algorithms: K-means, DBSCAN.
  - 2D visualization and interpretation of results.
  - Exercises: Using a clustering algorithm on a Dataset, Visualizing clusters.

- **Chapter 6: Neural networks**

  - Architecture of a neural network: Perception, Hidden layers, weights, biases. Activation function: ReLU, Sigmoid, Softmax, etc.
  - Application exercises.
  - Introduction to Deep Learning: Concept of deep layers, Introduction to convolutional networks (CNN).
  - Exercises: Explain TensorFlow and PyTorch, Analyze a text Dataset and predict sentiments.

- **Chapter 7: Mini project (Personal work)**

- Creation of a complete classification or clustering model (preprocessing, training, visualization). Choose from: Handwritten character recognition, Natural disaster prediction, Chatbot development, Machine anomaly sound detection, Social media sentiment analysis.

Practical work:

- **Lab 1: Initialization.**

- **Lab 2: Simple regression:** Implement a simple regression with Scikit-learn and visualize results with Matplotlib.

- **Lab 3: Machine learning pipeline:** Data separation and deepening of class concepts.

- **Lab 4: Supervised classification:** Use of Scikit-learn to train a simple supervised classification model.

- **Lab 5: Unsupervised clustering:** Implement a clustering algorithm (K-means, DBSCAN) on a Dataset and visualize the clusters.

- **Lab 6: Neural networks:** Build a simple neural network with TensorFlow, PyTorch or Keras. Build a simple CNN to classify images (e.g., MNIST Dataset).

Evaluation Method: Continuous Assessment: 40%; Exam: 60%.

Bibliographical references:

- Ganascia, J.Gabriel (2024) : l'IA expliquée aux humains. Paris France- Edition le Seuil.

- Anglais, Lise, Dilhac, Antione, Dratwa, Jim et al. (2023) : L'éthique au coeur de l'IA. Quebec Obvia.

- J.Robert (2024) : Natural Language Processing (NLP) : définition et principes – Datasciences. Lien : https://-datascientest.com/introduction-au-nlp-natural-language-processing

- Qu'est-ce que le traitement du langage naturel. Lien : https://aws.amazon.com/fr/what-is/nlp/

- M.Journe : Eléments de Mathématiques discrètes – Ellipses

- F.Challet : L'apprentisage profond avec Python – Eyrolles

- H.Bersini (2024) : L'intelligence artificielle en pratique avec Python – Eyrolles

- B.Prieur (2024) : Traitement automatique du langage naturel avec Python – Eyrolles

- V.Mathivet (2024) : Implémentation en Python avec Scikit-learn – Eyrolles

- G.Dubertret (2023) : Initiation à la cryptographie avec Python – Eyrolles

- S.Chazallet (2023) : Python 3 – Les fondamentaux du langage - Eyrolles

- H.Belhadef, I.Djemal : Méthode TALN – Cours de l'unievrsité de Msila - Algérie

V - Detailed Program by Subject for Semester S3

Materials

Semester: 3
Teaching Unit: CU 2.1.1
SCH: 45h00 (Lecture: 1h30, Tut: 1h30)

Credits: 4
Coefficient: 2

Teaching objectives: Understanding the link between microstructure and mechanical behavior.

Recommended prior knowledge: Physical Metallurgy, Materials Science.

Content of the subject:

- **Chapter 1: Perfect and imperfect crystal structures**

- **Chapter 2: Metallic materials and phase transformations**

- **Chapter 3: Non-metallic materials (Polymers and Ceramics)**

- **Chapter 4: Composite materials and behaviors**

- **Chapter 5: Material selection criteria and databases**

Evaluation Method: Continuous assessment 40%, Final Exam 60%.

Bibliographical references:

- Traité des matériaux, Introduction à la science des matériaux, J.P.Mercier, G.Zambelli, W.Kurz, Presses polytechniques et universitaire romande.

- Science et génie des matériaux, W.D.Callister,jr, MODULO.

- Choix des matériaux en conception mécanique NP, par Michael F. Ashby, Collection: Technique et Ingénierie, Dunod/L'Usine Nouvelle, 2012,

- Science et génie des matériaux, par William-D et Jr Callister, Editions Modulo, 2001

- Sélection des matériaux et des procédés de mise en œuvre, par Michael Ashby, Yves Bréchet, Luc Salvo, PPUR (Presses Polytechniques Universitaires Romandes), 2001.

- Traité des matériaux volume 20 : sélection des matériaux et des procédés de mise en œuvre, par ASHBY Michael, Edition LAVOISIER, 2001.

- Caractérisation expérimentale des matériaux I (TM volume 2) : Propriétés physiques, thermiques et mécaniques, par Suzanne Degallaix et Bernhard Ilschner, Collection PPUR (Presses Polytechniques Universitaires Romandes), 2007 .

Dynamics of Rotating Machines

Semester: 3

Teaching Unit: CU 2.1.1

SCH: 45h (Lecture : 01h30, Tut : 1h30)

Credits: 4

Coefficient: 2

Teaching objectives: Mastering calculation methods for rotors and shaft vibration.

Recommended prior knowledge: Structural dynamics.

Content of the subject:

- **Chapter 1: Introduction to rotor dynamics and Coordinate systems**

- **Chapter 2: Simple rotor model and Campbell diagram**

- **Chapter 3: Finite element modeling of rotors**

- **Chapter 4: Torsional vibrations of rotors**

- **Chapter 5: Influence of bearings on vibrations**

- **Chapter 6: Rotor balancing techniques**

Evaluation Method : Continuous Assessment: 40%, Exam: 60%.

Bibliographical references :

- Lee C.W., Vibration Analysis of Rotors.Dordrecht, Kluwer AcademicPublishers, 1993.

- G. Genta, , Dynamics of Rotating Systems,Springer, New York, 2005.

- Friswell M.I., Penny J.E.T., Garvey S.D., Lees A.W., Dynamics of Rotating Machines, Cambridge University Press, 2010.

- Lalanne M., Ferraris G., Rotordynamics Prediction in Engineering, 2nd edition, Chichester, John Wiley, 1998.

- Krämer E. Dynamics of Rotorsand Foundations, Springer-Verlag, New York , 1993.

- Childs D., TurbomachineryRotordynamics: Phenomena, Modeling,and Analysis, John Wiley & Sons, New York, NY, USA,1993.

Steel framework

Semester: 3

Teaching Unit: CU 2.1.1

SCH: 22h30 (Lecture : 1h30)

Credits: 2

Coefficient: 1

Teaching objectives: Theoretical basis for design and calculation of steel structures.

Recommended prior knowledge: MoM, Civil Engineering basics.

Content of the subject:

- **Chapter 1: General design criteria for a steel framework (3 weeks)**

- **Chapter 2: Design and calculation of metallic industrial halls (4 weeks)**

- **Chapter 3: Design of multi-story building frames (3 weeks)**

- **Chapter 4: Base plates and column foot anchoring (3 weeks)**

- **Chapter 5: Constructive arrangements and execution details (2 weeks)**

Evaluation Method : Exam: 100%.

Bibliographical references :

- Picard, Beaulieu, Tromblay, Calcul des charpentes d'acier tome I PBTGM.

Composite materials

Semester: 3
Teaching Unit: CU 2.1.2
SCH: 45h (Lecture : 01h30, Tut : 1h30)

Credits: 4
Coefficient: 2

Teaching objectives: Study of mechanical behavior of anisotropic heterogeneous materials.

Recommended prior knowledge: Solid mechanics.

Content of the subject:

- **Chapter 1: Generalities on composite materials and their applications (2 weeks)**

- **Chapter 2: Constituents obtaining processes and composites manufacturing (2 weeks)**

- **Chapter 3: Mechanical properties of composites (3 weeks)**

- **Chapter 4: Elastic behavior of a unidirectional composite (4 weeks)**

- **Chapter 5: Thermomechanical behavior of a unidirectional composite (1 week)**

- **Chapter 6: Bending behavior of composite laminates (3 weeks)**

- **Chapter 7: Fractures and damage of composites (2 weeks)**

Evaluation Method : Continuous Assessment: 40%, Exam: 60%.

Bibliographical references :

- Matériaux composites, Comportement mécanique et analyse des structures, Jean-Marie BerthelotHermès - Lavoisier.

- Matériaux et surfaces en tribologie, de Jamal Takadoum ,editionhermes 2001.

- Matériaux composites , Auteur Claude Bathias, dunod 2005.

- Matériaux composites a matrices organiques v15 - Constituants, Procédés, Propriété. Traite Des Matériaux, Auteur(s) : J. Manson, P.-E. Bourban, L. Carlsson, J.-p. Mercier, Éditeur : Presses polytechniques et universitaires romandes.

Fracture mechanics and fatigue

Semester: 3
Teaching Unit: CU 2.1.2
SCH: 45h (Lecture : 01h30, Tut : 1h30)

Credits: 4
Coefficient: 2

Teaching objectives: Estimation of mechanical durability and crack propagation analysis.

Recommended prior knowledge: Elasticity.

Content of the subject:

- **Chapter 1: Mechanical characterization and cyclic loadings (1 week)**

- **Chapter 2: Fatigue domains and endurance curves (5 weeks)**

- **Chapter 3: Linear elastic fracture mechanics (4 weeks)**

- **Chapter 4: Material behavior at crack tips and plastic zones (3 weeks)**

- **Chapter 5: Initiation and propagation of fatigue cracks (2 weeks)**

Evaluation Method: Continuous assessment: 40%; Exam : 60%

Bibliographical references :

- RECHO Naman, Mécanique de la rupture par fissuration - Aspects théorique, conceptuel et numérique, Editeur : Lavoisier, 2012.

- Alain Cardou, Plasticité, fatigue et rupture des matériaux métalliques : modèles mécaniques, Editeur : Loze-Dion éditeur, 2006.

- Ralph I Stephens, Ali Fatemi, Robert R Stephens, Henry O Fuchs, Metal fatigue in engineering , John Wiley & Sons, 2000.

- JaapSchijve, Fatigue of Structures and Materials , Kluwer Academic Publishers, 2004.

- C. Bathias, J.P. Baillon, Fatigue des matériaux et structure , Hermesedition, 1997.

- D. François, A. Pineau, A. Zaoui, Comportement mécanique des matériaux , Hermès 1992.

- André Pineau, Claude Bathias, Fatigue of Materials and Structures Fundamentals . John. Wiley & Sons, 2010.

- Prashant Kumar, Elements of Fracture Mechanics , Tata McGraw-Hill Education, 2000.

- Bannantine J, Comer J, Fundamentals of metal fatigue analysis, Prentice Hall, 1990.

- Richard HA, Sander M, Fatigue crack growth , Springer, 2016.

Methods Department

Semester: 3
Teaching Unit: MU 2.1
SCH: 45h00 (Lecture : 1h30, Lab : 01h30)

Credits: 4
Coefficient: 2

Teaching objectives: Mastering industrial process planning and tool positioning.

Recommended prior knowledge: Manufacturing techniques.

Content of the subject:

- **Chapter 1: Introduction (Production function, Role of methods department) (2 weeks)**

- **Chapter 2: Isostatics (3 weeks)**

- **Chapter 3: Manufacturing dimensioning and transfer (3 weeks)**

- **Chapter 4: Elementary operations and anteriorities due to machining constraints (2 weeks)**

- **Chapter 5: Complete manufacturing process establishment and routing design (5 weeks)**

Practical work:

- **Lab 1-5:** Part drawing analysis, isostatics, and dimensioning transfers.

- **Lab 6-8:** Study of elementary turning, milling, and drilling/boring operations with cutting regimes.

- **Lab 9-10:** Machining anteriorities and operation counts based on surface quality.

- **Lab 11-12:** Matrix method for machining order (revolution and arbitrary parts).

- **Lab 13-15:** Machining routing projects and phase contracts.

Evaluation Method: Continuous assessment: 40%, Exam :60 %.

Bibliographical references :

- Anselmetti B., 'Manuel de tolérancement (Volume 4): Cotation de fabrication avec les normes ISO' , Hermes Science Publications, 2010.

- Gara S., 'Productique - Procédés d'usinage :Tournage, fraisage, perçage, rectification', Editions Ellipses Marketing, 2014

- Pimbaud L., Layes G., Moulin J., 'Guide pratique de l'usinage (tome 1)', Edition Hachette, 2003.

- Barlier C., Poulet B., 'Productique mécanique' , Collection Mémotech, Editions Casteilla, 1999

- Chevalier A, Bohan J., Molina A., 'Guide pratique de productique' , Editions Hachette, 2000.

- Padilla P. et Thely A., ' Guide des Fabrications Mécaniques', Dunod, 1978.

- Padilla P., Anselmetti B., Mathieu L. et Raboyeau M., ' ProductionMécanique', Editions Dunod, 1986.

- Weill R., 'Conception des gammes d'usinage' , Techniques de l'ingénieur Doc B2 025, 1993

- Matthieu L. et Weill R., ' A Model for Machine Tool Setting as a Function of Positioning Errors' CIRP International WorkingSeminar on Computer-Aided Tolerancing,The Pennsylvania State University, 1991.

- Hassin S., 'Qualification multi-crit'eres des gammes d'usinage : application aux piéces de structure aéronautique en alliage Airware' , Thèse de doctorat, Université Blaise Pascal - Clermont-Ferrand II, 2015.

- André Chevalier, «Guide du dessinateur industriel», Hachette technique, 2004.

- Saber A, « L'analyse de fabrication le préparateur le bureau des méthodes», Alger : Technologie, p. 328.

- JP Trotignon et al., «Précis de construction mécanique», Tome 2, Projet-Méthodes, Production, Normalisation», Nathan, 2006.

- Georges Paquet, « Guide de l'usinage», Delagrave, 2000.

- R Quatremer et al., « Précis de construction mécanique », Tome 1, Projets-Etudes, Composants, Normalisation, Pierre de Coubertin, Paris: Nathan, 2006.

- Bruce Anglade – Hélène Horsin Molinaro, «Taillage des engrenages par génération, outil fraise-mère», Polycopié de cours, Ecole normale supérieure Paris-Saclay, 2017.

- Bruce Anglade – Hélène Horsin Molinaro, «Taillage des engrenages sans génération», Polycopié de cours, Ecole normale supérieure Paris-Saclay, 2017.

- JP Trotignon et al., «Précis de construction mécanique», Vol. 2, Pierre de Coubertin, Paris : Nathan, 2002.

- Philippe DEPEYRE, «Fabrication mécanique», Polycopié de cours, Université de la Réunion, 2004-2005.

- EugideLalé MBUNDA, «Essai de modélisation de la fonction de production dans une entreprise industrielle. Cas du complexe théicole de Butuhe "CTB SPRL" de 2003 à 2008», Université du CEPROMAD, 2008.

- Xavier BLOUËT, «La fonction Méthodes industrielles : Pivot de la compétitivité industrielle», Elite Organisation, 17/12/2015. [Consulté le 18/01/2020]. Disponible sur :http://www.elite-organisation.fr/a-propos/references/parole-d-expert/291-la-fonction-methodes-industrielles-pivot-de-la-competitivite-industrielle.html.

- Cristian Hohmann, «Lean trasformation model», Depuis 1988. [Consulté le 18/01/2020]. Disponible sur : http://christian.hohmann.free.fr/index.php/lean-entreprise/lean-management/346-lean-transformation-model.

- Vieille B, «Méthodes et fabrication», Conservatoire National des Arts et Métiers- production automatisée, 2017.

- Philippe Berger, «Isostatisme-Symbolisation des éléments technologiques», 2017. [Consulté le 18/01/2020]. Disponible sur : http://philippe.berger2.free.fr/ productique/ ressources/ isostatisme/isostatisme.htm

- «Fabrication mécanique-cours gratuit de génie mécanique, l'isostatisme et symbolisation technologique», 2013. [Consulté le 18/01/2020]. Disponible sur: https://fabrication1.blogspot.com/2013/09/lisostatisme.html

- JF Debongnie, «Complément de fabrication mécanique et FAO (MECA2453)», Polycopié de cours, Université de Liège, 2010. Disponible sur : http://hdl.handle.net/2268/26025.

- Ion-Cosmin GRUESCU, «Le transfert de cotes (TC)», 2015. [Consulté le 18/01/2020]. Disponible sur : http://analyse-fabrication.univ-lille1.fr/co/ch4_1_2.html.

Turbomachinery

Semester: 3
Teaching Unit: MU 2.1
SCH: 37h30 (Lecture : 1h30, Lab : 1h00)

Credits: 3
Coefficient: 2

Teaching objectives: Understanding energy transfer in hydraulic and thermal machines.

Recommended prior knowledge: Fluid dynamics.

Content of the subject:

- **Chapter 1: General definitions of turbomachines (1 week)**

- **Chapter 2: Similarities in turbomachines (2 weeks)**

- **Chapter 3: Pumps (Axial/Centrifugal), powers and efficiencies (3 weeks)**

- **Chapter 4: Cavitation in pumps (2 weeks)**

- **Chapter 5: Coupling of centrifugal pumps (1 week)**

- **Chapter 6: Sizing of centrifugal pumps (2 weeks)**

- **Chapter 7: Hydraulic turbines (Pelton, Francis, Kaplan) (3 weeks)**

Evaluation Method : Continuous Assessment: 40%, Exam: 60%.

Bibliographical references :

- Dixon (1998), Fluid mechanics and thermodynamics of turbomachinery, 4thed Butterworth-Heinemann

- Albin BOLCS (1990), Turbomachines thermiques, EPFL Lausanne, VOL 1 & 2.

- R. Comolet, Mécanique expérimentale des fluides, Tome II, dynamique des fluides réels, turbomachines, Editions Masson, 1982.

- B. Lakshminarayana, Fluid Dynamics and Heat Transfer of Turbomachinery, Wiley, New York, 1996.

Numerical simulation software in mechanics

Semester: 3
Teaching Unit: MU 2.1
SCH: 22h30 (Lab : 1h30)

Credits: 2
Coefficient: 1

Teaching objectives: Advanced simulation of industrial mechanical problems.

Recommended prior knowledge: Computer methods.

Practical work:

- **Lab 1-3:** Linear statics problems (1D bar/beam, 2D planar, 3D solids).

- **Lab 4-5:** Geometric and Material non-linearities (Large deformation, buckling, plasticity, creep).

- **Lab 6-8:** Contact, Thermomechanical problems, and Anisotropic (Composite) materials.

- **Lab 9-10:** Natural frequencies and Harmonic analysis.

- **Lab 11-12:** Rigid dynamic analysis and Transient heat transfer.

Evaluation Method : Continuous Assessment: 100%.

Bibliographical references :

Documentary research and thesis design

Semester: 3
Teaching Unit: TU 2.1
SCH: 22h30 (Lecture: 1h30)

Credits: 1
Coefficient: 1

Teaching objectives: Acquisition of search techniques and scientific drafting.

Recommended prior knowledge: General culture.

Content of the subject:

- **Part I: Documentary research**

  - **Chapter I-1: Defining the subject (2 weeks)**
  - **Chapter I-2: Selecting information sources (2 weeks)**
  - **Chapter I-3: Locating documents (1 week)**
  - **Chapter I-4: Processing information (2 weeks)**
  - **Chapter I-5: Bibliography presentation (1 week)**

- **Part II: Thesis design**

  - **Chapter II-1: Plan and stages of the thesis (2 weeks)**
  - **Chapter II-2: Writing techniques and norms (2 weeks)**
  - **Chapter II-3: Workshop: Critical study of a manuscript (1 week)**
  - **Chapter II-4: Oral presentations and defenses (1 week)**
  - **Chapter II-5: How to avoid plagiarism? (1 week)**

Evaluation Method: Exam : 100%

Bibliographical references :

- M. Griselin et al., Guide de la communication écrite, 2e édition, Dunod, 1999.

- J.L. Lebrun, Guide pratique de rédaction scientifique : comment écrire pour le lecteur scientifique international, Les Ulis, EDP Sciences, 2007.

- A.Mallender Tanner, ABC de la rédaction technique : modes d'emploi, notices d'utilisation, aides en ligne, Dunod, 2002.

- M. Greuter, Bien rédiger son mémoire ou son rapport de stage, L'Etudiant, 2007.

- M. Boeglin, lire et rédiger à la fac. Du chaos des idées au texte structuré. L'Etudiant, 2005.

- M. Beaud, l'art de la thèse, Editions Casbah, 1999.

- M. Beaud, l'art de la thèse, La découverte, 2003.

- M. Kalika, Le mémoire de Master, Dunod, 2005.

Reverse Engineering

Semester: 3
Teaching Unit: TU 2.1
SCH: 45h00 (Lecture : 1h30 and Workshop : 1h30)

Credits: 2
Coefficient: 2

Teaching objectives: Reconstruction of CAD models from physical objects.

Recommended prior knowledge: 3D modeling.

Content of the subject:

- **Chapter 1: Introduction to Reverse Engineering**

- **Chapter 2: General methodology**

- **Chapter 3: Hardware reverse engineering**

- **Chapter 4: Software reverse engineering**

- **Chapter 5: Mechanical reverse engineering**

- **Chapter 6: Security and intrusion detection**

- **Chapter 7: Real case studies**

Practical work:

- **Electrical Eng:** Reverse engineering of an electronic module without a schematic.

- **Mechanical Eng:** Reverse engineering of a simple mechanism (disassembly, 3D scan, CAD reproduction).

- **Civil Eng:** Analysis and retro-design of existing structures without plans.

- **Process Eng:** Reverse engineering of a laboratory module (PFD/PID reconstruction).

Evaluation Method : Exam : 60% Lab : 40%

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

Proposal of some discovery subjects

Tribology

Semester: X

Teaching Unit: EU X.X

SCH: 22h30 (Lecture 1h30)

Credits: 1

Coefficient: 1

Teaching objectives: Understand the interactions between surfaces in relative motion, focusing on friction, wear, and lubrication.

Recommended prior knowledge: Materials Science, Fluid Mechanics.

Content of the subject:

- **Chapter 1: Introduction to tribology and surface topography (2 weeks)**

- **Chapter 2: Study of friction and inducing vibrations (4 weeks)**

- **Chapter 3: Forms of wear and wear testing methods (3 weeks)**

- **Chapter 4: Elastic contact between two solid bodies (4 weeks)**

- **Chapter 5: Introduction to hydrodynamic and hydrostatic lubrication (2 weeks)**

Evaluation Method: Exam: 100%.

Bibliographical references:

- Stolarski T., Tribology in Machine Design , Butterworth-Heinemann Publisher, 1999.

- Frêne J., Nicolas D., Degueurce B., Berthe D. et Godet M., Lubrification hydrodynamique : paliers et butées , Editons Eyrolles, 1990.

- Georges J. M., Frottement, usureetlubrification , CNRS Editions, EditonsEyrolles, 2000.

- Johnson K.L., Contact Mechanics , Cambridge University Press, 1985.

- Williams J.A., Engineering Tribology , Ed.by Oxford University Press Inc., 1994.

- Kapsa P., La Tribologie: Fondamentaux Et Applications Complexes, Presse de l'école des mines, 2014.

- Takadoum J., Matériaux et surfaces en tribologie, Editeur : Hermès / Lavoisier , 2007.

- Hutchings I. M., Tribology: Friction and Wear of Engineering Materials , Publisher: CRC Press, 1992.

- Stachowiak G., Batchelor A.W., Engineering Tribology, Fourth Edition , Publisher: Butterworth-Heinemann, 2013.

Non-destructive testing (NDT)

Semester: x
Teaching Unit: EU xx
SCH: 22h30 (Lecture : 1h30)

Credits: 1
Coefficient: 1

Teaching objectives: Familiarization with techniques for detecting internal and surface defects without altering the material.

Recommended prior knowledge: Material Physics, Materials Science.

Content of the subject:

- **Chapter 1: Introduction**

- **Chapter 2: Basic principles**

- **Chapter 3: Liquid penetrant testing**

- **Chapter 4: Magnetic particle testing**

- **Chapter 5: Eddy current testing**

- **Chapter 6: Ultrasonic testing**

- **Chapter 7: Acoustic emission**

- **Chapter 8: Radiography**

Evaluation Method: Exam: 100%.
Bibliographical references:

Production management

Semester: x
Teaching Unit: EUxx
SCH: 22h30 (Lecture : 1h30)

Credits: 1
Coefficient: 1

Teaching objectives: Mastering production planning and inventory control methods.

Recommended prior knowledge: Statistics, Industrial Organization.

Content of the subject:

- **Chapter 1: Evolution of production management**

- **Chapter 2: Systematic approach to production management**

- **Chapter 3: Tools for production management**

- **Chapter 4: Technical organization of production management**

- **Chapter 5: Support logistics**

- **Chapter 6: Evaluation and control of the production system**

Evaluation Method: Exam: 100%.

Bibliographical references:

- L. Boyer, M. Poirée E. Salin, Précis d'organisation de la gestion de la production, Les éditions d'organisation, Paris (1986)

Industrial safety

Semester: x
Teaching Unit: EUxx
SCH: 22h30 (Lecture 1h30)

Credits: 1
Coefficient: 1

Teaching objectives: Understanding safety standards and risk analysis in industrial environments.

Recommended prior knowledge: General Physics, Management.

Content of the subject:

- **Chapter 1: Generalities (Hazards and Risks)**

- **Chapter 2: Lighting**

- **Chapter 3: Noise**

- **Chapter 4: Vibrations**

- **Chapter 5: Electrical risk**

- **Chapter 6: Chemical risk**

- **Chapter 7: Ionizing radiations**

Evaluation Method: Exam: 100%.

Bibliographical references:

- N. MARGOSSIAN, "Risques professionnels", Ed. Dunod, 2006.

- N. MARGOSSIAN, "Guide pratique des risques professionnels", Ed. Dunod, 2003.

- J. RIDLEY and J. CHANNING, "Safety at Work", Ed. Butterworth-Heinemann, 2003.

- C. D. REESE, J. V. EIDSON, "Handbook of OSHA Construction, Safety and Health", Ed. CRC Press, 2006.

- D. MACDONALD, "Practical Machinery Safety", Ed. Elsevier, 2004.

- T. KLETZ, "Learning from Accidents", Ed. Butterworth-Heinemann, 2001.

- L. R. COLLINS, T. D. SCHNEID, "Physical Hazards of the Workplace", Ed. CRC Press, 2001.

- S. LAGRA, "Prévention technique des risques professionnels", Ed. OPU, 1990.

- P. VANDEPLANGUE, "L'éclairage", Ed. Techniques et Documentations Lavoisier, 1993.

- M. LATOISON, "Introduction à l'éclairagisme", Ed. Eyrolles, 1982.

- H. NEY, "3. Installations électriques", Ed. Nathan, 1986.

- J. TOURRET, "Les bruits industriels", Ed. Cetim, 1978.

- T. SOUTH, "Managing Noise and Vibration at Work", Ed. Elsevier, 2004.

- C. AZAIS, J. P. GUILHOT, P. JOSSERAND, M. WILD, "Acoustique industrielle",Techniques de l'ingénieur, R3120.

Hydraulic and Pneumatic Systems

Semester: x
Teaching Unit: EU xx
SCH: 22h30 (Lecture 1h30)

Credits: 1
Coefficient: 1

Teaching objectives: Mastery of circuit design for fluid power transmission.

Recommended prior knowledge: Fluid Mechanics.

Content of the subject:

- **Chapter 1: Introduction and reviews (2 weeks)**

- **Chapter 2: Pumps, compressors and hydraulic motors (6 weeks)**

- **Chapter 3: Other components used in hydraulic and pneumatic circuits (3 weeks)**

- **Chapter 4: Practical examples (4 weeks)**

Evaluation Method: Exam: 100%.

Bibliographical references:

- Jacques Faisandier, Mécanismes hydrauliques et pneumatiques, Collection: Technique et Ingénierie, Dunod/L'Usine Nouvelle, 2013.

- José RoldanViloria, Aide-mémoire : Hydraulique Industrielle, L'Usine Nouvelle - Dunod.

- R.-C. Weber, Sécurité des systems pneumatiques, Édition Festo, 2012.

- Simon Moreno, Edmond Peulot, Pneumatique dans les systèmes automatisés de production, Editeur(s) : Casteilla, 2001.

Inspection and control

Semester: x
Teaching Unit: EU xx
SCH: 22h30 (Lecture 1h30)

Credits: 1
Coefficient: 1

Teaching objectives: Mastering quality control and industrial metrology tools.

Recommended prior knowledge: Statistics, GPS tolerancing.

Content of the subject:

- **Chapter 1: Digitization (5 weeks)**

- **Chapter 2: Coordinate Measuring Machine (CMM) (5 weeks)**

- **Chapter 3: Software associated with CMM (5 weeks)**

Evaluation Method: Exam: 100%.

Bibliographical references:

- Métrologie tridimensionnelle "cours machine à mesurer tridimensionnelle ". INSTITUT UNIVERSITAIRE DE TECHNOLOGIE DE MULHOUSE. 26/04/2005.

- SPRUYT.G. Métrologie tridimensionnelle "Technologie des Machines à Mesurer tridimensionnelle". I.S.I.P.S.

- SPRUYT.G. Métrologie tridimensionnelle "Technologie des Machines à Mesurer.

- Alain April, Claude Laporte : Assurance Qualité Logicielle 1 -concepts de base, Hermes-Lavoisier; 2011, ISBN 9782746231474.

- GROUS Ammar, Contrôle de qualité appliquée - Études de cas et nouvelle organisation du travail, Hermes – Lavoisier, 2013.

- Pierre CUÉNIN, Contrôle. Qualité, Techniques de l'Ingénieur, Référence M3530 v1, 1997.

Mechanisms of motion transformation and cams

Semester: X

Credits: 1

Teaching Unit: EU X.X

Coefficient: 1

SCH: 22h30 (Lecture 1h30)

Teaching objectives: Kinematic analysis and design of cams and linkages.

Recommended prior knowledge: General Mechanics, Mechanism Theory.

Content of the subject:

- **Chapter 1: Review of mechanism theory (3 weeks)**

- **Chapter 2: Technology of linkage mechanisms (3 weeks)**

- **Chapter 3: Kinematic analysis and synthesis of cam mechanisms (6 weeks)**

- **Chapter 4: Indexers (3 weeks)**

Evaluation Method: Exam: 100%.

Bibliographical references:

- MARTIN J., Mécanismes de transformation de mouvement à contact local – Mécanismes à came, Techniques de l'ingénieur, 2004.

- Vinogradov O. Fundamentals of kinematics and dynamic of machines and mechanisms, CRS Press, 2000.

- DAVID H. MYSZKA., Machines and Mechanisms- Applied Kinematic Analysis, Prentice Hall, 2012.

- Techniques de l'ingénieur, B 5 910 Construction mécanique, Esnaut Tome 1.

Industrial Hygiene and Safety (IHS)

Semester: x   **Credits:** 1
Teaching Unit: EU xx   **Coefficient:** 1
SCH: 22h30 (Lecture : 1h30)

Teaching objectives: Protecting worker health through ergonomics and environmental stress control.

Recommended prior knowledge: Biology, Industrial Management.

Content of the subject:

- **Chapter 1: Job function analysis (3 weeks)**

- **Chapter 2: Hazardous materials management and remediation support (3 weeks)**

- **Chapter 3: Occupational safety analysis and risk assessment (3 weeks)**

- **Chapter 4: Preparation of material safety data sheets (3 weeks)**

- **Chapter 5: Litigation support and expert testimony (3 weeks)**

Evaluation Method: Exam: 100%.

Bibliographical references:

- Isabelle Correard, Patrick Anaya, Sécurité, hygiène et risques professionnels, Edition(s) : Dunod, 2011.

- Nathalie Diaz, Le grand guide des responsables QHSE : Qualit, Hygiène, Sécurité, Environnement, Lexitis Editions, 2014.

- Benoît Péribère, Le guide de la sécurité au travail : Les outils du responsable, AFNOR Editions, 2013.

- Michel Lesbats, Précis de gestion des risques - L'essentiel du cours, fiches-outils et exercices corrigés, Edition(s) : Dunod, 2012.

- Ryan Dupont, Louis Theodore, Joseph Reynolds, Sécurité industrielle: De la prévention des accidents à l'organisation des secours, problèmes résolus, études de cas, Editeur : Polytechnica, 1999.

- Georges-G Paraf, Vve C. Dunod, Hygiène et sécurité du travail industriel, Hachette Livre, 2015.

- Jean-Pierre Mouton, La sécurité en entreprise - 3e édition: Sensibilisation des personnels et mise en oeuvre d'un plan d'action, Edition(s) : Dunod, 2010.

Industrial maintenance

Semester: x
Teaching Unit: EU xx
SCH: 22h30 (Lecture : 1h30)

Credits: 1
Coefficient: 1

Teaching objectives: Implementation of maintenance strategies to improve equipment reliability.

Recommended prior knowledge: Statistics, Reliability.

Content of the subject:

- **Chapter 1: Generalities and Definitions on Industrial maintenance (2 weeks)**

- **Chapter 2: Maintenance organization (1 week)**

- **Chapter 3: Maintenance methods and techniques (2 weeks)**

- **Chapter 4: Availability and RAM concepts (4 weeks)**

- **Chapter 5: Machine file and technical documentation (1 week)**

- **Chapter 6: Maintenance costs (3 weeks)**

- **Chapter 7: CMMS (Computerized Maintenance Management System) (2 weeks)**

Evaluation Method: Exam: 100%.

Bibliographical references:

- Jean-Claude Francastel, Ingénierie de la maintenance : De la conception à l'exploitation d'un bien, Editeur(s) : Dunod, L'Usine Nouvelle, Collection : Technique et ingénierie - Gestion industrielle, 2009.

- François Castellazzi, Yves Gangloff, Denis Cogniel, Maintenance industrielle : Maintenance des équipements industriels, Editions : Cateilla, 2006.

- Pascal Denis, Pierre Boyé, André Bianciotto, Guide de la maintenance industrielle, Editions : Delagrave, 2008.

- Serge Tourneur, La maintenance corrective dans les équipements et installations électriques : Dépannage et mesurage, Editions : Cateilla, 2007.

- Jean-Marie Auberville, Maintenance Industrielle De L'Entretien De Base A L'Optimisation De La Surete, Editions : Ellipse.

- Sylvie Gaudeau, Hassan Houraji, Jean-Claude Morin, Julien Rey, Maintenance des équipements industriels. Tome 1 : Du composant au système. Editions : Hachette.

Energy Audit

Semester: x
Teaching Unit: EUxx
SCH: 22h30 (Lecture : 1h30)

Credits: 1
Coefficient: 1

Teaching objectives: Assessing energy performance and proposing efficiency improvements.

Recommended prior knowledge: Thermodynamics, Heat Transfer.

Content of the subject:

- **Chapter 1: Generalities on energy (2 weeks)**

- **Chapter 2: Energy audit (Industrial, Tertiary, Building) (4 weeks)**

- **Chapter 3: Energy audit methodology (4 weeks)**

- **Chapter 4: Implementation of an energy management system (2 weeks)**

- **Chapter 5: Case study (3 weeks)**

Evaluation Method: Exam: 100%.

Bibliographical references:

- L'audit énergétique, P-A Bernard, 1995

- Guide technique d'audit énergétique, K. Moncef et M. Dominique, 2016

- Bilans matières et énergétiques, G. Henda, 2012

- www.aprue.org.dz

- Aidan Duffy, Martin Rogers and LacourAyompe, Renewable Energy and Energy Efficiency: Assessment of Projects and Policies, Wiley-Blackwell, 2015.

- D. Yogi Goswami, Frank Kreith, Handbook of Energy Efficiency and Renewable Energy, CRC Press, 2007.

- Journal Officiel de La République Algérienne N° 84 29, Décret exécutif n° 05-495 du 24 Dhou El Kaada 1426 correspondant au 26 décembre 2005 relatif à l'audit énergétique des établissements grands consommateurs d'énergie.

Renewable energy

Semester: x
Teaching Unit: EUxx
SCH: 22h30 (Lecture : 1h30)

Credits: 1
Coefficient: 1

Teaching objectives: Understanding principles and technologies of sustainable energy sources.

Recommended prior knowledge: General Physics, Energy conversion.

Content of the subject:

- **The Solar Resource (2 weeks)**

- **Thermal Conversion: Low Temperature Applications (3 weeks)**

- **Photovoltaic Conversion (2 weeks)**

- **Geothermal Energy (2 weeks)**

- **Wind Energy (2 weeks)**

- **Hydroelectric Energy (1 week)**

- **Biomass Energy (1 week)**

- **Marine (or oceanic) Energy (1 week)**

- **Solar Energy Storage (1 week)**

Evaluation Method: Exam: 100%.

Bibliographical references:

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- Energie solaire. Calcul et optimisation - Génie énergétique, Jacques Bernard, Edition : Ellipses, 2004.

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- D. P. Kothari, K. C. Singal and RakeshRanjan "Renewable Energy Sources and Emerging Technologies", PHI Lear. Priv. Ldt (2008)

- J. Duffie, and W. Beckman: Solar Engineering of Thermal Processes, John Wiley & Sons, New York, 1991

- Charles Wereko-Brobby: Biomass Conversion and Technology, John Wiley & Sons, 1996

- B. H. Khan "Non-Conventional Energy Resources McGraw Hill, 2nd Edn, 2009

- Héliothermique: Le gisement solaire, méthodes et calculs, Pierre-Henri Communay, Edition GRE, 2002.

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Electronics

Semester: x
Teaching Unit: EUxx
SCH: 22h30 (Lecture : 1h30)

Credits: 1
Coefficient: 1

Teaching objectives: Study of basic analog and digital electronic circuits.

Recommended prior knowledge: Electricity, Physics.

Content of the subject:

- **Chapter 1: Preliminary concepts - Reviews**

- **Chapter 2: Sinusoidal steady state**

- **Chapter 3: The diode and its applications**

- **Chapter 4: The bipolar transistor and its applications**

- **Chapter 5: The linear integrated circuit and its applications**

Evaluation Method: Exam: 100%.

Bibliographical references:

Electrotechnics

Semester: x
Teaching Unit: EU xx
SCH: 22h30 (Lecture : 1h30)

Credits: 1
Coefficient: 1

Teaching objectives: Understanding energy conversion through electrical machines and transformers.

Recommended prior knowledge: Circuits, Magnetism.

Content of the subject:

- **Chapter 1: Three-phase systems**

- **Chapter 2: The transformer**

- **Chapter 3: DC machines**

- **Chapter 4: Synchronous machines**

- **Chapter 5: Asynchronous machines**

Evaluation Method: Exam: 100%.

Bibliographical references: