الجمهورية الجزائرية الديمقراطية الشعبية
People's Democratic Republic of Algeria
وزارة التعليم العالي والبحث العلمي
Ministry of Higher Education and Scientific Research

University

Logo

Training Offer
L.M.D.

Academic LICENCE

NATIONAL PROGRAM
2021– 2022
(2nd Revision)

Establishment	Faculty / Institute	Departement

Domain	sector	Speciality
Science and Technology	***mechanical engineering***	***Construction mécanique***

Semester 5

Teaching unit	Subjects	Credits	Coefficient	Weekly hourly volume			Semestrial Hourly Volume (15 WeeKs)	Additional Work in Consultation (15 WeeKs)	Evaluation method	
	Title			Course	TuT	PW			Continuous Control	Exam
Fundamental unit Code: FUT 3.1.1 Credits: 10 Coefficients: 5	Analytical mechanics	6	3	3h00	1h30		67h30	82h30	**40%**	**60%**
	Mechanical Construction1	4	2	1h30	1h30		45h00	55h00	**40%**	**60%**
Fundamental Unit Code: FUT 3.1.2 Credits: 8 Coefficients: 4	Material resistance 2	4	2	1h30	1h30		45h00	55h00	**40%**	**60%**
	Elasticity	4	2	1h30	1h30		45h00	55h00	**40%**	**60%**
Methodological Unit Code : MUT 3.1 Credits : 9 Coefficients : 5	Industrial Drawing	4	2			3h00	45h00	55h00	**100%**	
	Computer-Assisted Design and Manufacturing	4	2			3h00	45h00	55h00	**100%**	
	PW Metrology	1	1			1h00	15h00	10h00	**100%**	
Discovery unit Code : DUT 3.1 Credits : 2 Coefficients : 2	Servo Control and Regulation	1	1	1h30			22h30	02h30		**100%**
	Maintenance	1	1	1h30			22h30	02h30		**100%**
Transversal unit Code :TUT 3.1 Credits : 1 Coefficients : 1	Environment and sustainable development	1	1	1h30			22h30	02h30		**100%**
Total semester 5		**30**	**17**	**12h00**	**6h00**	**7h00**	**375h00**	**375h00**		

Semester: 5
Teaching Unit: UEF 3.1.1
Subject: Analytical Mechanics
Total Hours (VHS): 67 hours (course: 3h00, TUT: 1h30)
Credits: 6
Coefficient: 3

Learning Objectives

This course provides students with the necessary tools to analyze mechanical problems, to choose the most appropriate solution method based on the nature of the problem, its data, and its unknowns. The course is divided into two parts: the first part focuses on solid dynamics using classical mechanics, while the second part deals with analytical mechanics through the application of energy principles in solving mechanical problems.

Recommended Prerequisites

Rational Mechanics, Physics 1, Mathematics

Course Content

Part A: Supplementary Concepts in Solid Mechanics

Chapter 1: Dynamics of Solid Bodies (3 weeks)

Translation Motion, Rotation about a Fixed Axis, Planar Motion. Motion of a Rigid Body about a Fixed Point in Space, Euler's Equation, Euler Angles, Motion of a Rigid Body in Space. Central Force Motion.

Chapter 2: Elements of Kinetics (1 weeks)

Inertia Tensor. Kinetic Energy

Part B: Analytical Mechanics

Chapter 3: Fundamental Concepts (2 weeks)

Mechanical Constraints and Their Classifications, Mechanical Systems and Their Classifications, Constraint Equation, Possible and Virtual Displacements, Degrees of Freedom, Work of Constraint Forces, Generalized Coordinates and Velocities, Coordinate Transformation Equations.

Chapter 4: Principle of Virtual Work (1 week)
Chapter 5: D'Alembert's Principle (1 week)
Chapter 6: Lagrange's Equations of the First Kind (1 week)
Chapter 7: Lagrange's Equations of the Second Kind (3 weeks)
Chapter 8: Hamilton's Equations (3 weeks)

Hamiltonian Formalism, Hamilton's Equation, Routh's Equation.

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

Bibliographic References:

a. S. Targ, *Éléments De Mécanique Rationnelle*, éditions Mir, Moscou.
b. J. Starjinski, *Mécanique rationnelle* , édition Mir, Moscou.

c. V. I. Arnold, *Les méthodes mathématiques de la mécanique classique*, Editions Mir, Moscou.
d. H. Cabannes, *Problèmes de mécanique générale*, Dunod.
e. M. Combarnous, D. Desjardin& C. Bacon, *Mécanique des solides et des systèmes : Cours et exercices corrigés*, Dunod.
f. W. B. Kibble & F. H. Berkshire, *Classical Mechanics*, 5th Edition, Imperial College Press.
g. G. Kotkine& V. Serbo, Recueil *de problèmes de mécanique classique- réponses et solutions*, éditions Mir, Moscou.
h. Jozef HERING, *Cours de mécanique, Mécanique analytique*, OPU, Alger, 1993.

Semester: 5
Course Unit: UEF 3.1.1
Subject: Mechanical Construction 1
Total Hours (VHS): 45h00 (course: 1h30, TUT: 1h30)
Credits: 4
Coefficient: 2

Course Objectives:

To provide students with scientific and technological training in the field of mechanical design by introducing them to standard machine elements and components used in the construction of mechanical structures, mechanisms, and machines. The course also covers their standardization and the mechanical transmission of power.

Recommended Prerequisites

Industrial Drawing, Strength of Materials SOM., Mechanical Manufacturing Processes.

Course Content:

Chapter 1: Introduction (2 weeks)
General Overview (Mechanical Design, Study of Design, Safety Factor, Standards, Economy, Reliability).).

Chapter 2: Threaded Assemblies (3 weeks)
Screws, Bolts, Studs, Strength Calculation (Shear, Bearing, Bending, Tightening of a Hyperstatic System).

Chapter 3: Non-Detachable Assemblies (4 weeks)
Riveting (Different Types of Rivets and Riveting, Dimensioning Calculation, etc.)
Welding (Different Types of Welds, Welding Calculations: Butt, Edge, Fillet, Cylindrical, Dynamic Load, etc.).

Chapter 4: Assembly of Parts by Force Fit (3 weeks)
Introduction, Advantages, Disadvantages, Strength Calculation (Axial Load, Torsional Moment).
Assembly by Hub Heating, Assembly by Shaft Cooling, Fit Calculation.

Chapter 5: Obstacle Elements (3 weeks)
Keys, Splines, and Springs (Dimensioning and Strength Calculation).

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

Bibliographic References:

2. Buchet Jean David Morvan. *Les engrenages* Ed. : Delcourt G. Productions 01/2004
3. Georges Henriot. *Les engrenages* Ed. : Dunod
4. Alain Pouget , Thierry Berthomieu , Yves Boutron, Emmanuel Cuenot. *Structures et mécanismes - Activités de construction mécanique* Ed. Hachette Technique
5. R. Quatremer, J-P Trotignon, M. Dejans, H. Lehu. *Précis de Construction Mécanique*, Tome 1, *Projets-études, composants, normalisation*, AFNOR, NATHAN 2001.
6. R. Quatremer, J-P Trotignon, M. Dejans, H. Lehu. *Précis de Construction Mécanique, Tome 3, Projets-calculs, dimensionnement, normalisation*, AFNOR, NATHAN 1997.
7. YoudeXiong, Y. Qian, Z. Xiong, D. Picard. *Formulaire de mécanique, Pièces de construction*, EYROLLES, 2007.
8. Jean-Louis FANCHON. *Guide de Mécanique*, NATHAN, 2008.
9. Francis ESNAULT. *Construction mécanique, Transmission de puissance, Tome 1, Principes et Ecoconception*, DUNOD, 2009.

10. Francis ESNAULT. *Construction mécanique, Transmission de puissance, Tome 2, Applications*, DUNOD, 2001.
11. Francis ESNAULT, DUNOD. *Construction mécanique, Transmission de puissance, Tome 3, Transmission de puissance par liens flexibles*, 1999.
12. Bawin, V. et Delforge, C., *Construction mécanique* , Edition originale : G. Thome, Liège, 1986.
13. M. Szwarcman. *Eléments de machines*, édition Lavoisier 1983
14. W. L. Cleghorn. M*echanics of machines*, Oxford University Press, 2008.

Semester: 5
Teaching Unit: UEM 3.1.2
Subject: Strength of Materials 2
Total Hours (VHS): 45 hours (course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Course Objectives:

This course is a continuation of the Strength of Materials taught in the fourth semester. It will cover combined stresses, energy methods, and hyperstatic systems.

Recommended Prerequisites:

Strength of Materials 1, Materials Science, Mathematics

Course Content:

Chapter 1: Planar Bending of Symmetric Beams – Review (2 weeks)

- Review of Bending Moment – Shear Force.
- Normal Stresses in Simple Bending
- Shear Stresses in Simple Bending

Chapter 2: Displacement of Symmetric Beams in Planar Bending (2 weeks)

- Displacement of Beams with Constant Cross-Section
- Initial Parameters Method
- Moment-Area Method
- Superposition Method

Chapter 3: General Theorems of Elastic Systems (Applications) (3 weeks)

- Elastic Strain Energy in Tension
- Elastic Strain Energy in Torsion
- Elastic Strain Energy in Shear
- Elastic Strain Energy in Bending
- General Expression for Elastic Strain Energy
- Castigliano's Theorem
  Generalized Virtual Force Method

Chapter 4: Combined Stresses (3 weeks)

- Generality
- Curved Bending (Generalities, Stresses, Deformations)
- Combined Bending
- Bending-Torsion

Chapter 5: Solution of Hyperstatic Systems (4 weeks)

- General Overview (Bar Systems, Nodes, Joints, Frames, Portal Frames, etc.)
- Initial Parameters Method
- Superposition Method for Force Effects
- Three-Moment Equations Method
- Force Method

Chapter 6: Design Examples – Applications **(1 week)**
Assessment Method: Continuous Assessment: 40%; Final Exam: 60%.

Bibliographic References:

1. A. Giet ; L. Geminard. *Résistance des matériaux*, Editions Dunod 1986, Paris.
2. S. P. Timoshenko. *Résistance des matériaux*, Editions Dunod ; Paris.
3. M. Albiges, ; A Coin .*Résistance des matériaux*, Editions Eyrolles 1986 ; Paris.
4. Jean-Claude Doubrère. *Résistance des matériaux*, Editions Eyrolles 2013
5. YoudeXiong. *Exercices résolus de résistance des matériaux*, Editions Eyrolles, 2014.
6. Claude Chèze. *Résistance des matériaux - Dimensionnement des structures, Sollicitations simples et composées, flambage, énergie interne, systèmes hyperstatiques*, Ellipses, 2012.

Semester: 5
Course Unit: UEF 3.1.2
Subject: Elasticity
Total Hours (VHS): 45h00 (course: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Course Objectives:

This course introduces the fundamental concepts of elasticity, focusing on stress and strain tensors as well as Hooke's laws.

Recommended Prerequisites:

- Algebra
- Differential and Integral Calculus
- Matrix Calculations
- Strength of Materials

Course Content:

Chapter 1: Introduction, Mathematical Review **(3 weeks)**
Index Notation, Vector Calculus, Tensor Calculus.

Chapter 2: Stress Tensor **(4 weeks)**

- Sectioning, Surface Element, and Stress Vector
- Cauchy's Formula, Stress Tensor
- Equilibrium Equations
- Principal Stresses and Principal Directions
- Scalar Invariants of the Stress Tensor
- Spherical Tensor and Deviator

Chapter 3: Strain Tensors **(3 weeks)**

- Displacement Vector
- Strain Tensor
- Length and Angle Transformations
- Principal Strains
- Scalar Invariants of the Strain Tensor
- Spherical Tensor and Deviator

Chapter 4: Hooke's Laws (Stress–Strain Relationships) **(4 weeks)**

- Stress-Based Formulation
- Strain-Based Formulation
- Thermoelastic Formulation

Chapter 5: Strength Criteria **(1 week)**

- Maximum Normal Stress Criterion (Rankine Criterion)
- Maximum Shear Stress Criterion (Tresca Criterion)
- Von Mises Criterion

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

Bibliographic References:

1. Harry Lass , Vector and Tensor Analysis, McGraw-Hill, 1950
2. A. I. Borisenko and I. E. Tarapov, Vector and Tensor Analysis, Dover, 1979
3. Frank Ayres, Matrices Cours et Problèmes, Schaum,1983
4. Martin H. Sadd. Elasticity : Theory, applications and Numerics, Elsevier 2005.
5. Yves Debard. Elasticité, Université Lemans, 2006.
6. Guenfoud M., Introduction à la mécanique des milieux continus application à la mécanique des solides, Université de 8 mai 1945 Guelma, 2006.
7. Gabriel Lamé. Leçons sur la théorie mathématique de l'élasticité des corps solides, Editions Jacques Gabay, Paris 2006.
8. Denis Dartus. Elasticitélinéaire, Editions Cépaduès, paris 1995.
9. Jean Coirier. Mécanique des milieux continus, Cours et exercicescorrigés, Dunod, 2013.

Semester: 5
Teaching Unit: UEM 3.1
Subject: Technical Drawing (Industrial Drawing)
Total Hours (VHS): 45 hours (Practical Work PW: 3h00)
Credits: 4
Coefficient: 2

Course Objectives:

This course complements the technical drawing course from Semester 4. It enables students to acquire the principles of standardized representation of mechanical parts, known as industrial drawing. Furthermore, it allows students to create and interpret drawings of mechanisms and machines. The course also aims to enhance the student's graphical imagination to master this universal language of communication among technicians, and ultimately prepares them for effective use of DAO-CAO tools.

Recommended Prerequisites:

Technical Drawing, General Technology, and Conventional Mechanical Manufacturing Processes.

Course Content:

Chapter 1: Basic Mechanical Functions **(3 weeks)**

Mechanical joints (elementary joint, joint characteristics, joint methods, joint implementation).Centering and orientation functions (rotational guidance, translational guidance, functional dimensioning, fits, technical specifications and symbols).

Chapter 2: Drawing Interpretation **(3 weeks)**

Sketches, dimensions, kinematic diagrams, assembly drawings, detail drawings, exploded views.

Chapter 3: Drawing Analysis (**5weeks**)

Assembly of bearings, thrust bearings, joints, plain bearings, stops, gears, lubrication function, sealing, dimension chains.

Chapter 4: Application – CAD of a Mechanical System (**4 weeks**)

Modeling of various parts
Assembly including the use of standard part libraries (bearings, screws, etc.)
Drawing layout (tolerances, functional clearances, fits, etc.)

Note :

- Chapters 1 and 2 constitute the mechanical technology section and should be presented as lectures accompanied by application examples.
- The student's personal work for this subject should be assigned in the form of a mini-project.:
    - Creation of the assembly drawing of a mechanism and the detailed drawings of its individual components, including fit calculations and application of functional dimensioning.

- Use of DAO to draw a set of parts, perform the assembly, and finally present the technical drawing with all relevant details (dimensioning, technological symbols, etc.).

Assessment Method: Final Exam: 100%..

Bibliographic References:

1. Chevalier A. *Guide du dessinateur industriel*, Editions Hachette Technique,
2. Saint-Laurent, GIESECKE, Frederick E. *Dessin technique*, Éditions du renouveau pédagogique Inc., 1982.
3. Jean-Louis Berthéol, François Mendes. *Exercices de dessins de pièces et d'assemblages mécaniques avec le logiciel SolidWorks*, Edition Castilla 2007
4. Lenormand, Foucher. *Mémento de dessin industriel T1: Convention de présentation cotation*, Edition Dunod
5. Heurtematte J. *Aide mémoire de dessin de l'élève dessinateur et du dessinateur industriel,* Delagrave.
6. Norbert M.*Aide-mémoire de l'élève dessinateur*, Casteilla.
7. , J-Louis Franch. *Guide des sciences et technologies industrielle,*. DUNOD
8. Michel Denis. *Le dessin assisté par ordinateur.* Editions Hermes 2008
9. Sites internet du *modeleur volumique SolidWorks* (forum – tutoriaux – exemples)

Semester: 5
Teaching Unit: UEM 3.1
Subject: Computer-Aided Design and Manufacturing (CFAO)
Total Hours (VHS): 45 hours (Practical Work PW: 3h00)
Credits: 4
Coefficient: 2

Course Objectives:

This course allows students to become familiar with the use of FAO software on one hand, and to be introduced to Computer-Aided Manufacturing (FAO) and gain familiarity with CNC machine tools on the other hand.

Recommended Prerequisites:

Technical Drawing, Mechanical Manufacturing, D.A.O.

Course Content:

CAO Part

- Introduction and use of CAD software. **(1 week)**
- Techniques for reconstructing curved surfaces - Bézier curves, poles, NURBS - B-splines: basic functions, properties. **(2 weeks)**
- Complex surfaces, concepts of curvature, connectivity, junctions. **(2weeks)**
- CAD tools for shape design - Design of a parameterized 2D system - An example of polyhedral modeling. **(2 weeks)**
- Design of stamped shapes, mold impressions. **(2 weeks)**

FAO Part

- Introduction to CNC machines (various components and parts). Positioning parts on the machines. Selection of cutting tools and definition of their geometries. Setting the part origin. **(2 weeks)**

Machining a part by turning and analysis of the program generated by the software. **(2 weeks)**

- Machining a part by milling and analysis of the program generated by the software. **(2 weeks).**

Assessment Method: Continuous Assessment: 100%

Bibliographical References:

1. A. Cornand, F. Kolb& J. Lacombe. Usinage et commande numérique*, T2,* , 1992,
2. G. Faidherbe & B. Vacossin, Cetim*. L'Environnement des centres d'usinage*, Senlis, 1991,
3. B. Froment & J.-J. Lesage*. Productique. Les techniques de l'usinage flexible*, Dunod, Paris, 1988
4. P. Gonzalez. *La Commande numérique par calculateur : tournage, fraisage, centres d'usinage*, Casteilla, Paris, 1993
5. C. Hazard. *La Commande numérique des machines-outils*, Foucher, 1984
6. *Machines-outils : calculs, bases fondamentales, éléments de construction*, Vander, Bruxelles, 1969
7. C. Marty, C. Cassagnes& P. Marin*. La Pratique de la commande numérique des machines-outils*, Tec & Doc, Paris, 1993.
8. J. W. Oswald & S. F. Krar*. Technology of Machine Tools*, McGraw-Hill, New York, 4e éd. 1989
9. A. Cornand, F. Kolb& J. Lacombe, *Usinage et commande numérique*, t. II, Foucher, Paris, 1992
10. Centre international technique d'enseignement et de formation, *La Commande d'axe*, C.I.T.E.F., Rueil-Malmaison, 1991

11. G. Faidherbe & B. Vacossin, *L'Environnement des centres d'usinage*, Cetim, Senlis, 1991
12. P. Gonzalez, *La Commande numérique par calculateur : tournage, fraisage, centres d'usinage*, Casteilla, Paris, 1993
13. R. Kibbe, J. Neely, R. Meyer et al., *Machine Tool Practices*, Prentice-Hall, New York, 1991
14. C. Marty, C. Cassagnes& P. Marin, *La Pratique de la commande numérique des machines-outils*, Tec & Doc, Paris, 1993
15. J. W. Oswald & S. F. Krar, *Technology of Machine Tools*, McGraw-Hill, New York, 4e éd. 1989
16. J. Vergnas, *Usinage : technologie et pratique*, Dunod, Paris, 2e éd. 1989
17. A.Chevalier- J..Bohan- A.Molina ; *Guide pratique de la productique*
18. C.Barlier – B-Poulet *; Memotech –Génie mécanique- Productique Mécanique*
19. A.Chevalier et J. Bohan ; *Guide du technicien en fabrication mécanique*

Semester: 5
Teaching Unit: UEM 3.1
Subject: Laboratory on Metrology
Total Hours (VHS): 15 hours (PW: 1h00)
Credits: 1
Coefficient: 1

Objectives of the Course:

The metrology PW will allow students to become familiar with and handle various measurement techniques. They will learn about measuring instruments with direct and indirect readings used in mechanics.

Recommended Prerequisite Knowledge:

Metrology Course, Applied Mathematics, Technical Drawing, Mechanical Manufacturing, D.A.O.

Course Content:

PW1 (in two parts): Calibration of measuring and control devices for lengths (Vernier caliper, micrometer, dial indicator, and depth gauge). Concepts of calibration, errors, and measurement uncertainty.
PW 2: Checking inclinations, angles, and cones.
PW 3: Checking threads and gears.
PW 4: Checking geometric form tolerances: circularity, cylindricity, straightness, flatness, parallelism, eccentricity, etc.
PW 5: Checking surface roughness and surface condition.
PW6: Use of special control devices.

Assessment Method: Continuous Assessment: 100%

Bibliographical References:

1. Jean Claude HOCQUET, *métrologie*, EncyclopædiaUniversalis,:http://www.universalis.fr/encyclopedie/metrologie/
2. Ammar Grous. *Métrologie appliquée aux sciences et technologies - Volume 1*Hermès - Lavoisier 2009

Semester: 5
Teaching Unit: UED 3.1
Subject: Control and Regulation
Total Hours (VHS): 22h30 (course: 1h30)
Credits: 1
Coefficient: 1

Teaching Objectives:

To recognize the main control techniques for mechanical systems and the components involved.

Recommended Prerequisites:

Mathematics, Numerical Methods

Course Content:

Chapter 1: Terminology of Control Systems **(1 week)**
Functional diagram of a feedback control system. Components of a functional diagram in a feedback system.

Chapter 2: Laplace Transform **(2 weeks)**
Definitions and properties.

Chapter 3: Transfer Functions **(2 weeks)**
Block diagram algebra and system transfer functions.

Chapter 4: Study of First-Order Control Systems **(3 weeks)**
Definition and transfer function. System response to various input signals.

Chapter 5: Study of Second-Order Control Systems **(3 weeks)**
Definition and transfer function. System response to various input signals. Representation of the system in the complex plane.

Chapter 6: BODE and Nyquist Diagrams of Control Systems **(2 weeks)**

Chapter 7: Stability Analysis of Control Systems (2 weeks)
Analytical stability criteria according to Routh and Hurwitz. Geometric stability criterion according to Nyquist.

Assessment Method: Exam: 100%.

Bibliographic References

1- Henri Bourles. *Systèmes linéaires de la modélisation à la commande*. Editions Lavoisier 2006, Paris.
2- Jean Marie Flans .*La régulation industrielle*; Hermès 1994 ; Paris.
3- Philippe de Larminat. *Automatique commande des systèmes linéaires.* Editions Hermès 1996 ; Paris
4- Patrick *Prouvost. Automatique – Contrôle et régulation*, EditionDunod 2010.

5- Yves GRANJON. *Automatique* . Edition Dunod 2010
6- Olivier Le Gallo. *Automatique des systèmes mécaniques*. Edition Dunod , 2009
7- Gérard Boujat, Patrick Anaya. *Automatique industrielle*, 2007. Edition Dunod
8- JANET Maurice. *Précis de calcul matriciel et de calcul opérationnel*, Edition Euclide 1982
9- Patrick Prouvost. *Automatique – Contrôle et régulation*. Edition Dunod 2010.

Semester: 5
Teaching Unit: UED 3.1
Subject: Maintenance
Total Hours (VHS): 22h30 (course: 1h30)
Credits: 1
Coefficient: 1

Course Objectives:

Through this subject, the student will gain an understanding of the role of maintenance within a company, its organization, as well as its various functions. The student will also be able to perform calculations related to reliability.

Recommended Prerequisites:

Course Content:

Chapter 1: General Maintenance Overview (2 weeks)

- Importance of maintenance in a company
- Objectives of maintenance in a company
- Maintenance policies in a company

Chapter 2: Different Forms of Maintenance (4 weeks)

- Types of maintenance actions
- Maintenance operations
- Levels of maintenance
- Related activities of maintenance

Chapter 3: Maintenance Organization (4 weeks)

- Preparation of maintenance work
- Maintenance work planning
- Human resource management
- Studies and methods office

Chapter 4: Equipment Tracking and Logistics (2 weeks)

- Knowledge and behavior of equipment
- Logistic function

Chapter 5: Maintenance Reliability (3 weeks)

- Maintenance and reliability
- Reliability indicators
- Reliability calculation
- Failure mode analysis and causes (FMEA)

Assessment Method: Exam: 100%.

Bibliographic References

1- GODELIER E. *La culture d'entreprise* ,Éditeur : La Découverte - 30/08/2006
2-Boitel D., Hazard C. *Guide de la maintenance,* Edition Elisabeth Ponard Avril 1990.
3- Auberville J. M. *Maintenance industrielle – de l'entretien de base à l'optimisation de la sureté* Edition Ellipses – Juin 2004.
4- Zwingelstein G. *La maintenance basée sur la fiabilité* Edition HERMES, 1996.
5- Vernier J. P. *Fonction maintenance* A 8300 Techniques de l'ingénieur.
6- Bleux J. M., Fanchon J. L. *Maintenance : Systèmes automatisés de production*, Edition Nathan Janvier 2000.
7- FD X60- 000 *Maintenance industrielle : Fonction maintenance,* Normalisation française. Mai 2002.
8- Ridoux M. *AMDEC-Moyen*. Techniques de l'Ingénieur, traité L'entreprise industrielle. AG 4 220.

Semester: 5
Course Unit: UET 3.1
Subject: Environment and Sustainable Development
VHS: 22h30 (course: 1h30)
Credits: 1
Coefficient: 1

Course objectives:

To raise students' awareness of the relationship between energy, the environment, and sustainable development, and to master the sources of pollution; to reduce them in order to ensure sustainable development.

Recommended prior knowledge:

Fluid mechanics, fundamental thermodynamics, heat transfer, and environmental characteristics.

Content of the course:

Chapter 1: Introduction to the Concept of Environment (2 Weeks)
Definition of the environment, general definition, legal definition, brief history, man and the environment, how humans have altered their environment, demography as a scapegoat.

Chapter 2: The Concept of Sustainable Development (2 Weeks)
Definition, brief history, the fundamental principles of sustainable development, the ethical principle, the precautionary principle, the prevention principle, the objectives of sustainable development, environmental challenges of sustainable development.

Chapter 3: Environment and Natural Resources (4 Weeks)
Introduction, resources, water, air, fossil fuels (oil, natural gas, coal,...), other energies (solar, wind, hydro, geothermal, biomass,...), mineral elements, biodiversity, soils, food resources.

Chapter 4: Substances (4 Weeks)
Different types of pollutants, regulated pollutants, organic compounds, heavy metals, particles, chlorofluorocarbons, effects of various substances on the environment, greenhouse effect and climate change, ozone layer destruction, acidification, eutrophication, and photochemistry, acid rains, ozone peaks; effects on materials; effects on ecosystems: forests, freshwater reserves, health effects. Different types of emitters, Corinair classification.

Chapter 5: Environmental Preservation (3 Weeks)
Introduction of new materials, reserving oil for noble uses, improving energy efficiency, recycling, economic, legal, and regulatory mechanisms for environmental preservation, the role of public authorities in solving environmental issues, the feasible option of private solutions, current environmental policies, the polluter-pays principle, ecological taxation: eco-taxes, the market for tradable emission permits.

Assessment Method: Exam: 100%.

Bibliographic References

1- De Jouvenel, B., « Le thème de l'environnement, Analyse et prévision », 10, pp. 517533, 1970.
2- Faucheux S., Noël J-F, « Economie des ressources naturelles et de l'environnement » , Armand Collin, Paris.

3- Reed D. (Ed.), « Ajustement structurel, environnement et développement durable », l'Harmattan, Paris, 1995.
4- Vivien F-.D, « Histoire d'un mot, histoire d'une idée : le développement durable à l'épreuve du temps », Ed. scientifiques et médicales Elsevier ASA, pp. 19-60, 2001.
5- Boutaud, Aurélien, Gondran, Natasha, « L'empreinte écologique », Paris : La Découverte, 2009.
6- Lazzeri, Yvette (Dir.), « préface de Gérard Guillaumin, Développement durable, entreprises et territoires: vers un renouveau des pratiques et des outils », Paris, L'Harmattan, 2008.

Semester 6

Teaching unit	Subjects	Credits	Coefficient	Weekly hourly volume			Semestrial Hourly Volume (15 WeeKs)	Additional Work in Consultation (15 WeeKs)	Evaluation method	
	Title			Course	TUT	PW			Continuous Control	Exam
Fundamental unit Code: FUT 3.2.1 Credits: 10 Coefficients: 5	Mechanical Construction 2	6	3	3h00	1h30		67h30	82h30	40%	60%
	Theory of mechanisms	4	2	1h30	1h30		45h00	55h00	40%	60%
Fundamental Unit Code: FUT 3.2.2 Credits: 8 Coefficients: 4	Thermal transfer	4	2	1h30	1h30		45h00	55h00	40%	60%
	Dynamics of structures	4	2	1h30	1h30		45h00	55h00	40%	60%
Methodological Unit Code : MUT 3.2 Credits : 9 Coefficients : 5	End of cycle project	4	2			3h00	45h00	55h00	100%	
	Internal combustion engine	4	2	1h30	1h30		45h00	55h00	40%	60%
	PW Thermal transfer	1	1			1h00	15h00	10h00	100%	
Discovery unit Code : DUT 3.2 Credits : 2 Coefficients : 2	Hydraulic and pneumatic systems	1	1	1h30			22h30	02h30		100%
	Non-metallic materials	1	1	1h30			22h30	02h30		100%
Transversal unit Code : TUT 3.2 Credits : 1 Coefficients : 1	Entrepreneurship and business management	1	1	1h30			22h30	02h30		100%
Total semester 6		**30**	**17**	**13h30**	**7h30**	**4h00**	**375h00**	**375h00**		

Semester: 6
Course Unit: UEF 3.2.1
Subject: Mechanical Construction 2
VHS: 67h00 (course: 3h00, TUT: 1h30)
Credits: 6
Coefficient: 3

Course Objectives:

This subject is a continuation of Mechanical Construction 1 (CM1). It mainly focuses on the dimensioning calculations for key motion transmission components in machines (gears, bearings, shafts, etc.). It also covers the general technological study of mechanisms such as reducers, gearboxes, clutches, brakes, etc.

Recommended Prerequisite Knowledge:

Rational mechanics, Industrial drawing, Strength of materials (RDM), and Mechanical Construction 1 (CM1).

Course Content:

Chapter 1: Gears (Study of Geometric Characteristics of Gear Cutting) (3 weeks)
- Cylindrical gears (straight and helical teeth)
- Conical gears (straight and helical teeth)
- Worm gears

Chapter 2: Introduction to the Dynamic Study of Gears (2 weeks)
- Surface pressure and breaking strength for cylindrical gears (straight and helical teeth)

Chapter 3: Shafts and Axes (3 weeks)
- Preliminary diameter calculation for shafts and axes
- Fatigue verification of shafts and axes

Chapter 4: Motion Transmission (Calculation and Dimensioning) (3 weeks)
- Bearings and bearing supports
- Belts and chains...

Chapter 5: Reducers and Gearboxes (2 weeks)
- Kinematic study of a speed reducer
- Kinematic study of a gearbox
- Concepts of epicyclic trains

Chapter 6: General Concepts of Couplings, Clutches, and Brakes (2 weeks)

Assessment Method: Continuous assessment: 40% Exam: 60%

Bibliographic References

1. Les engrenages (Buchet Jean David Morvan) Ed**. :**Delcourt G. Productions 01/2004
2. Les engrenages (Georges Henriot) Ed. : Dunod
3. Construction mécanique. Transmission de puissance – volume 3-(F.Esnault) Ed. Dunod

4. Alain Pouget , Thierry Berthomieu , Yves Boutron, Emmanuel Cuenot.*Structures et mécanismes - Activités de construction mécanique*. Ed. Hachette Technique
5. R. Quatremer, J-P Trotignon, M. Dejans, H. Lehu. *Précis de Construction Mécanique, Tome 1, Projets-études, composants, normalisation* , AFNOR, NATHAN 2001.
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8. Jean-Louis FANCHON. *Guide de Mécanique* , NATHAN, 2008.
9. Francis ESNAULT. *Construction mécanique, Transmission de puissance, Tome 1, Principes et Ecoconception*, DUNOD, 2009.
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12. W. L. Cleghorn. *Mechanics of machines*, , Oxford University Press, 2008.
13. A. CHEVALIER, *Guide du dessinateur industriel*, Edition HACHETTE technique, 1980.
14. Aublinmichel et al.,"systèmes mécaniques : *Théorie et dimensionnement*",Ed. Dunod, 1998
15. Drouin g. Et al.,*"Eléments de machines"*,*Ed.*Ecole polytechnique de montréal, 1986
16. J. E. Shigley, c. R. Mischke, "*Standard handbook of machine design*",Ed. Mc-graw-hill.
17. Richard g. Budynas, j. Keith nisbett, "shigley's mechanical engineering design", ed. Mc-graw-hill.
18. R. C. Juvinall,k. M. Marshek,"*Fundamentals of machines component design*",ed.JohnWiley &Sons.

Semester: 6
Course Unit: UEF 3.2.1
Subject: Theory of Mechanisms
VHS: 45 hours (course: 1h30, TUT: 1h30)
Credits: 4
Coefficient: 2

Objectives of the Course:

The content of this course will enable students to undertake an analysis or synthesis study of mechanical systems. At the undergraduate level, three essential parts must be considered: (i) a mathematical review covering the necessary mathematical tools for the study of mechanisms (torque, vector product, co-moment, linear systems, etc.); (ii) a thorough understanding of reading mechanical system plans in order to identify equivalence classes, contact graphs, standardized mechanical connections, minimal schematization, and classification of mechanisms; (iii) static and kinematic studies of parallel connections, series connections, and closed chains; (iv) an introduction to the study of cam-based motion transformation mechanisms, such as plotting the real and theoretical profiles of a cam and its follower diagram, etc.

Recommended Prerequisites:

Vector analysis, Industrial drawing, General technology, Mechanical fabrication, and Rational mechanics.

Algebra: Matrices, determinants, linear systems, and matrix operations.

Course Content:

Chapter 1: Preliminary and Reminders **(3 weeks)**
• Notion of the wrench and its characteristics
• Definitions and assumptions:
Machine, Mechanisms, Kinematic chain, Fixed element or frame, Kinematic coupling, Planar mechanisms, Spherical mechanisms, Spatial mechanisms, Example of mechanisms.
• Common mechanical couplings:

Chapter 2: Modeling of Mechanisms **(2 weeks)**
• Graph associated with a mechanical system
• Chains and kinematic diagrams of a mechanical system

Chapter 3: Mobility and Hyperstaticity of a Mechanism **(4 weeks)**
• Definitions: Kinematic and static analysis of parallel couplings
• Kinematic and static analysis of series couplings
• Kinematic and static analysis of closed chains
• Systematic search for isostatic solutions

Chapter 4: Kinematic Analysis of Planar Mechanisms **(3 weeks)**
• Definition of a planar mechanism
• Identification of parameters of a planar mechanism
• Grashoff's laws for 4-bar articulated mechanisms
• Analysis of the displacement of a planar mechanism (Graphical method, Analytical method, Case study)

Chapter 5: Introduction to CAD and Mechanism Synthesis (2 weeks)

• Design of an isostatic mechanism using CAD software (SolidWorks)
• Modeling and simulation of a mechanism using CAD-CAE software (e.g., SolidWorks)
• Simulation using the CosmosMotion module

Chapter 6: Generalities on Cam Mechanisms (1 week)

Assessment Method: Continuous assessment: 40% Exam: 60%

Bibliographic References

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2. Michel Aublin, René Boncompain.Systèmes Mécaniques. Théorie et dimensionnement,. Collection science Sup. Dunod 2005.
3. Marc Rossetto et Pierre Agati.Liaisons et Mécanismes. Dunod 1994
4. PartickBeynet.Sciences industrielle pour l'ingénieur. Ellipse édition Marketing S.A., 2012.
5. ViguenArakelian.Structure et cinématiques des mécanismes, Hermes 1997
6. Artobolovsky I. I. Théorie des mécanismes et des machineEdition Sciences Moscou 1988
7. R. le Borzec et J. Lotterie. Principe de la théorie des Mécanismes, édition DUNOD 1977
8. BOUDET- C. BORTOLUSSI. Présentation des mécanismes Techniques de l'ingénieur- B 600/8600,1 – R. 1980
9. Jean-Louis Fanchon. Guide des sciences et technologies industrielles. Edition DUNOD 2014.
10. HUNT K.H. Kinematicgeometryofmechanisms. EdtClordon Press oxford 1978
11. A. Caignot et al. Sciences industrielles de l'ingénieur MPSI.PCSI.PTSI, édition Vuibert,
12. A. Caignot et al.Sciences industrielles de l'ingénieur MP/MP*. PSI/PSI*.PT/PT*, édition Vuibert,
13. Jean-Dominique Mosser et al. Sciences industrielles de l'ingénieur Tout-En-Un, édition DUNOD,
14. Mécanique, Deuxieme partie (43e leçon. – Cames et 44e leçon. - Excentriques. Bielles à coulisse. Pédales et balanciers) RENE BASQUIN Edition Delagrave 1990
15. Formulaire de mécanique: Transmission de puissance Eyrrols 2006 Youde Xiong
16. تكنولوجيا الرسم الهندسي (الفصل 8: تصميم الكامات) ، فيرث و قاندر ويليجين الناشر ماكراوهيل

Semester: 6
Course Unit: UEF 3.2.2
Subject: Heat Transfer
VHS: 45 hours (courses: 1h30, TUT: 1h30)
Credits: 4
Coefficient: 2

Course Objectives:

Evaluate the conducted, convected, or radiated fluxes in different situations. Be able to model a thermal problem and solve it in steady-state conditions and simple geometries. Be capable of making the right material choice for any thermal application.

Recommended Prerequisites::

Thermodynamics and mathematics from L1 and L2.

Course Content:

Chapter 1. Heat Conduction (5 weeks)

• Introduction to heat transfer and its relation to thermodynamics.
• Basic laws of heat transfer.
• Fourier's Law.
• Thermal conductivity and the order of magnitude for common materials. Discussion of the parameters affecting thermal conductivity.
• The energy equation, simplifying assumptions, and its various forms. Spatial and initial boundary conditions. The four linear boundary conditions and their practical significance. Under what conditions can they be implemented?
• Some solutions to the heat equation in Cartesian, cylindrical, and spherical coordinates with boundary conditions and in steady-state conditions.
• Steady-state conduction with heat sources.
• Electrical analogy: Series and parallel resistances (composite materials and concentric cylinders).
• Fins: Types of fins, practical importance of fins. Equation of the longitudinal rectangular fin. Solutions for the four classical boundary conditions. Calculation of lost heat, efficiency, and effectiveness of the fin. Optimal thickness of longitudinal rectangular fins.

Chapter 2. Heat Transfer by Convection (4 weeks)

• Mechanisms of heat transfer by convection. Parameters involved in convective heat transfer.
• Identification of different types of convective transfer: Forced, natural, and mixed convection. Common examples. Differentiating between laminar and turbulent convective transfer in both forced and natural modes.
• Methods for solving a convection problem (Dimensional analysis and experiments, integral methods for boundary layer equations, solving equations representing convection and analogy with similar phenomena like mass transfer).
• Dimensional analysis with experiments: Pi Theorem, identifying the most commonly used dimensionless numbers in convection (Reynolds, Prandtl, Grashoff, Rayleigh, Peclet, and Nusselt numbers) for forced and natural convection. Explaining the significance of these numbers and the use of the most common correlations through concrete examples.

Chapter 3. Heat Transfer by Radiation (5 weeks)

• Introduction: Concepts of solid angles.
• Mechanism of radiative heat transfer by surface and volume.
• Definitions and general laws (Luminance, illuminance, intensity, emittance…).
• Bouguer's formula, Kirchhoff's law, and Draper's law.
• The black body (BB). Planck's Law. Flux emitted by the BB in a spectral band. Stefan-Boltzmann Law.
• Global radiative properties of gray surfaces and their interrelations.
• Radiative exchange between two parallel, infinitely extended planes separated by a transparent medium. Concepts of shielding.
• Radiative exchange between two concave black surfaces. Concepts of view factors. Reciprocity relations. Summation rule. Superposition rule. Symmetry rule. View factors between infinitely long surfaces. The method of crossed strings.
• Lost flux by a concave surface.
• Radiative exchange between n arbitrary surfaces forming an enclosure. Enclosure rules for view factors. The irradiation-radiance method for evaluating exchanged fluxes.
• Electrical analogy in radiative heat transfer.

Assessment Method: Continuous assessment: 40% Exam: 60%

Bibliographic References

1. Jean-Luc Battaglia, Andrzej Kusiak, Jean-Rodolphe Puiggali, *Introduction aux transferts thermiques, cours et solutions*, Dunod éditeur, Paris 2010.
2. J. F. Sacadura coordonnateur, *Transfert thermiques : Initiation et approfondissement*, Lavoisier 2015.
3. A-M. Bianchi , Y. Fautrelle , J. Etay, *Transferts thermiques*, Presses Polytechniques et Universitaires Romandes 2004
4. Kreith, F.; Boehm, R.F.; et. al., *Heat and Mass Transfer, Mechanical Engineering* Handbook Ed. Frank Kreith, CRC Press LLC, 1999.
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7. Y. A. Cengel, *Heat and Mass Transfer*, Mc Graw Hill
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9. F. P. Incropera and D. P. Dewitt, *Fundamentals of Heat and Mass transfer,* 6th edition, Wiley editor.
10. J. P. Holman, *Heat Transfer*, 6th edition, Mc Graw Hill editor, 1986.
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12. Chris Long and NaserSayma, *Heat Transfer,*Ventus Publishing APS, 2009
13. Hans Dieter Baehr, Karl Stephan, *Heat and Mass Transfer*, Springer editor, 2006

Semester: 6
Teaching Unit: UEF 3.2.2
Subject: Structural Dynamics
VHS: 45 hours (course: 1h30, tutorials: 1h30)
Credits: 4
Coefficient: 2

Objectives of the course:

Mastering the methods for studying the displacements and stresses imparted to a given structure subjected to an arbitrary dynamic load.

Recommended Prerequisites::

(RDM1), Solving Differential Equations.

Course Content:

Chapter 1: Introduction to Structural Dynamics (2 weeks)

- Objective of structural dynamics
- Characteristics of a dynamic problem
- Types of loading
- Simple harmonic motion
- Vector representation of harmonic motion

Chapter 2: Forced Vibrations of Single-Degree-of-Freedom Systems (3 weeks)

- Structure (Harmonic excitation, Periodic excitation, Arbitrary dynamic excitation)
- Response of a conservative structure
- Response of a damped structure

Chapter 3: Vibrations with Two Degrees of Freedom (3 weeks)

- Free vibrations (Concept of natural modes)
- Time response of an excited system

Chapter 4: Systems with N Degrees of Freedom (4 weeks)

- Matrix properties
- Frequency and mode calculations
- Response to excitation

Chapter 5: Vibration Measurement (2 weeks)

- Basic schematic
- Seismography
- Accelerometry
- Calibration

Assessment Method: Continuous assessment: 40% Exam: 60%

Bibliographic References

1- R. Glough, J. Penzien, *Dynamique des structures* Pluralis (1980)
2- M. Lalanne, P. Berthier, J.D.Hagopian, *Mécanique des vibrations linéaires* Masson (1980)
3- S.G.Kelly, *Mechanical Vibrations. Theory and applications*. Cengage learning (2012)
4- Thomas Gmür*Dynamique des Structures - Analyse Modale Numérique*, Presses Polytechniques et Universitaires Romandes,1997
5- Patrick Paultre. *Dynamique des structures*, , Hermès - Lavoisier, 2005,
6- Samikian A. *Analyse et calcul des structures* , Québec, 1984,
7- Studer M.A. et Frey F. *Introduction à l'analyse des structures,* Lausanne, 1997,
8- Clough R. et Penzien J. A. *Dynamics of Structures*, deuxième édition, C. Berkeley, 2004,

Semester: 6
Teaching Unit: UEM 3.2
Subject: Final Year Project
Total Hours (VHS): 45h00 *(PW: 3h00)*
Credits: 4
Coefficient: 2

Objectives of the course:

To assimilate, in a comprehensive and complementary way, the knowledge acquired from various subjects. To practically apply the concepts taught during the training. To foster students' autonomy and sense of initiative. To teach them to work in a collaborative environment while stimulating their intellectual curiosity.

Recommended Prerequisites:

All program of Licence.

Course Content:

The topic of the Final Year Project must result from a joint decision between the supervising instructor and a student (or a group of students: pairs or trios). The subject matter must necessarily align with the training objectives and the actual skills of the student (Bachelor's level). Furthermore, it is preferable for the topic to take into account the social and economic context of the institution. When the nature of the project requires it, it may be divided into several parts.

Note:
During the weeks in which students are familiarizing themselves with the purpose and feasibility of their project (literature review, research on necessary software or hardware, revision and consolidation of relevant coursework, etc.), the course supervisor should use the face-to-face time to review key content from the two subjects *"Writing Methodology"* and *"Presentation Methodology"* covered during the first two semesters of the core curriculum.

At the end of this study, the student must submit a written report that clearly presents:

- A detailed presentation of the chosen topic, emphasizing its relevance in the socio-economic context.
- The resources used: methodological tools, bibliographic references, professional contacts, etc.
- The analysis of the results obtained and their comparison with the initial objectives.
- A critique of any discrepancies observed and, if applicable, presentation of additional details.
- Identification of difficulties encountered, highlighting the limitations of the work performed and possible follow-up.

The student or student group will then present their work (in the form of a brief oral presentation or poster) before their supervising instructor and an examining instructor, who may ask questions and assess the work in terms of both technical content and presentation quality.

Assessment method: Continuous assessment: 100%

Bibliographic References

Semester: 6
Course Unit: UEM 3.2
Subject: Internal Combustion Engine
Total Hours (VHS): 45h00 (course: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Course Objectives:

To understand the operation of different types of internal combustion engines, both from a thermodynamic and a mechanical perspective.

Recommended Prerequisites:

Physics, Thermodynamics

Course Content:

Chapter 1: General Overview **(3 weeks)**
• Operating principle and classification of thermal engines
• Fuels used in internal combustion engines

Chapter 2: Thermodynamics of Engine Cycles **(4 weeks)**
• The Beau de Rochas cycle
• The Diesel cycle
• The Sabathé cycle
• Real cycles and efficiencies
• Energy balance
• Fuel supply system for gasoline engines
• Ignition system for gasoline engines
• Combustion

Chapter 3: Real Cycle of a Diesel-Type Internal Combustion Engine **(3 weeks)**
Intake; Compression; Combustion; Expansion; Exhaust; Indicated parameters; Effective parameters; Construction of the theoretical indicator diagram.

Chapter 4: Dynamics of Reciprocating Engines **(3 weeks)**
• Crank-connecting rod mechanism: Kinematic study – Dynamic study
• Valve train system: Kinematic study – Dynamic study
• Balancing

Chapter 5: Performance and Characteristics of Reciprocating Engines **(2 weeks)**
Performance parameters, Standards, Characteristics: Full load – Partial load – Universal

Note: It is essential to schedule a few practical lab sessions on internal combustion engines, depending on the available resources of the institution.

Assessment Method: Continuous assessment: 40% Exam: 60%

Bibliographic References

1. J. B. Heywood, *Internal Combustion Fundamentals*, McGraw Hill Higher Education 1989
2. P. Arquès, *Conception et construction des moteurs alternatifs*, Ellipse 2000
3. J-C. Guibet, Carburants et moteurs, 1997
4. P. Arquès, *Moteurs alternatifs à combustion interne* (Technologie), Masson édition 1987.
5. -FAMIN U.Y., GORBAN A.I., DOBROVOLSKY V.V, LUKIN A.I. et al. *Moteurs marins à combustion interne*. Leningrad:Sudostrojenij, 1989, 344p.
6. Menardon M. *Le moteur à explosion*, Paris, Deboeck ,98
7. Jolivet D. Le *moteur diésel*, Paris Ellipses ,86
8. Benabbassi A. *Les moteurs à combustion interne*, Introduction à la théorie, Alger, OPU. 2002.

Semester: 6
Teaching Unit: UEM 3.2
Subject: Heat Transfer Lab
Total Hours: 15h00 (PW: 01h00)
Credits: 1
Coefficient: 1

Course Objectives:

Consolidate knowledge in conduction and convection.

Recommended Prerequisites:

Physics, Thermodynamics

Course Content:

Plan a few experiments related to heat transfer according to available resources.

Assessment Method: Continuous assessment: 100%

Bibliographic References

Semester: 6
Course Unit: UED 3.2
Subject: Hydraulic and Pneumatic Systems
Total Hours (VHS): 22h30 (Course: 01h30)
Credits: 1
Coefficient: 1

Course Objectives:

The objective of the program is to provide students with a set of essential and necessary knowledge for the physical understanding of the main components of hydraulic and pneumatic systems.

Recommended Prerequisites::

Knowledge of fluid mechanics and thermodynamics.

Course Content:

Chapter 1: Introduction and Background (2 weeks)
Hydraulic fluids: different types of hydraulic fluids — mineral oil, synthetic oil, and water-based products; characteristics of hydraulic fluids. Viscosity: influence of temperature and pressure on viscosity. Flow regimes, Reynolds number, head losses. Filtration. Quality of intake air: humidity, contamination by solid particles, various types of air filters.

Chapter 2: Pumps and Compressors (4 weeks)
Positive displacement pumps and compressors: classification; axial piston pumps, radial piston pumps, vane pumps, gear pumps, screw pumps. Hydraulic and pneumatic motors: general concepts, motor classification — axial piston motors, radial piston motors, gear motors, vane motors, low-speed cam and roller motors.

Chapter 3: Actuators (Cylinders) (2 weeks)
Cylinders: classification; single-acting return cylinders, single-acting cylinders, basic double-acting cylinders, differential double-acting cylinders, double-rod double-acting cylinders, telescopic cylinders, rotary actuators. Stiffness of a cylinder: stiffness expression and calculation example. End-of-stroke cushioning, rod buckling.

Chapter 4: Hydraulic Lines (3 weeks)
Piping: rigid lines (materials and dimensions), flexible lines. Pressure regulation: direct-operated and pilot-operated pressure relief valves, pressure reducers. Flow control: flow limiters, flow regulators, check valves. Directional control valves, accumulators, and applications. Study of hydraulic and pneumatic systems.

Chapter 5: Practical Examples (3 weeks)

- Control of a pneumatic motor
- Control of a bidirectional hydraulic motor
- Speed control of a cylinder
- Design of a hydraulic circuit

Chapter 6: Simulation Software (1 week)
Simulation software for hydraulic and pneumatic systems (e.g., Automation Studio - Hydraulics, etc.)

Assessment Method: Exam: 100%

Bibliographic References

1. J. Faisandier :*Mécanismes hydrauliques et électro-hydrauliques.* Ed. Dunod 2006
2. Fawcett. *Applied hydraulics and pneumatics in industry*. Trade and Technical Press Ltd , 2009.
3. Gille,DecaulnePelegrin. *Théorie et technique des asservissements* ,Dunod
4. J. Faisandier*Mécanismes hydrauliques et pneumatiques*, Collection: Technique et Ingénierie, Dunod/L'Usine Nouvelle. 2013 - 9ème édition
5. *José Roldanveloria. Aide-mémoire* d'*hydraulique industrielle. Dunod 2004*
6. www.thierry-lequeu.fr/data/99ART147.HTM

Semester: 6
Course Unit: UED 3.2
Subject: Non-Metallic Materials
Total Hours (VHS): 22h30 (course: 01h30)
Credits: 1
Coefficient: 1

Course Objectives:

To introduce students to the science of non-metallic materials by providing them with knowledge specific to these materials. The focus will be particularly on polymer materials, ceramics, and composite materials.

Recommended Prerequisites:

Basic science knowledge acquired during the common core curriculum.

Course Content:

Chapter 1: Overview of Plastics **(2 weeks)**
Structures and properties, processing techniques, standardization.

Chapter 2: Introduction to Polymeric Materials **(3 weeks)**

- Nature and structure of polymeric materials
- Macromolecular chains, thermoplastic and thermosetting polymers
- Elastomers, amorphous and semi-crystalline polymers
- Properties of polymeric materials: mechanical properties, physical properties, thermomechanical tests, long-term behavior (aging), combustion
- Polymer processing techniques
    - Polymerization by addition or condensation

Chapter 3: Glass and Ceramics **(3 weeks)**

- Structure of inorganic glasses
- Types of ceramics and application fields
- Manufacturing and microstructure of ceramics
- Glass manufacturing and forming
- Mechanical, electrical, thermal, and optical properties
- Degradation of ceramics

Chapter 4: Composite Materials **(4 weeks)**

- Material combinations and anisotropy
- Constituents and their properties
- Manufacturing, forming, and properties of different composite families: polymer matrix, metal matrix, ceramic matrix, and foams
- Issues related to assembly and machining
- Mechanical testing
- Specific mechanical behavior of composite materials
- Calculation methods: homogenization, rule of mixtures, constitutive laws, failure criteria

Assessment Method: Exam: 100%

Bibliographic References

1. Wilfried Kurz, Jean P. Mercier. *Introduction à la science des matériaux2ième édition*.. 1991
2. Marc Carrega et Coll*Matériaux polymères*. Dunod, 2000
3. Traités des matériaux 14. *Matériaux polymères : propriétés mécaniques et physiques.* Presses polytechnique et universitaire Romandes. 2001
4. Claude Bathias et Coll*. Matériaux composites 2ième édition* . L'usine nouvelle Dunod, 2009

Semester: 6
Course Unit: UET 3.2
Subject: Entrepreneurship and Business Management
Total Hours (VHS): 22h30 (course: 1h30)
Credits: 1
Coefficient: 1

Course Objectives:

- Prepare students for professional integration upon graduation;
- Develop entrepreneurial skills among students;
- Raise awareness and familiarize students with the opportunities, challenges, procedures, characteristics, attitudes, and skills required for entrepreneurship;
- Equip students to eventually create their own business or, at the very least, better understand their role within an SME.

Recommended Prerequisites:

No specific prior knowledge is required, except proficiency in the language of instruction.

Targeted Skills:
Ability to analyze, synthesize, work in teams, communicate effectively both orally and in writing, be autonomous, plan and meet deadlines, and demonstrate responsiveness and proactivity. Develop awareness of entrepreneurship through an overview of management knowledge useful for business creation.

Course Content:

Chapter 1 – Operational Preparation for Employment: (2 weeks)
Writing a cover letter and developing a CV, job interviews, documentary research on careers in the field, conducting interviews with professionals, and job interview simulations.

Chapter 2 – Entrepreneurship and Entrepreneurial Spirit: (2 weeks)
Entrepreneurship, businesses around you, entrepreneurial motivation, setting goals, taking risks.

Chapter 3 – The Entrepreneur's Profile and the Entrepreneurial Profession: (3 weeks)
Qualities of an entrepreneur, negotiation skills, listening skills, the role of SMEs and very small enterprises (VSEs) in Algeria, key success factors in creating a VSE/SME.

Chapter 4 – Finding a Good Business Idea: (2 weeks)
Creativity and innovation, recognizing and evaluating business opportunities.

Chapter 5 – Launching and Operating a Business: (3 weeks)
Choosing the right market, selecting the business location, legal forms of business, seeking support and financing to start a business, recruiting staff, choosing suppliers.

Chapter 6 – Developing the Business Project: (3 weeks)
Business Model and Business Plan, implementing the business project using the Business Model Canvas.

Assessment Method: Exam: 100%

Bibliographic References

- FayolleAlain, 2017. Entrepreneuriat théories et pratiques, applications pour apprendre à entreprendre.Dunod, 3e éd.

- LégerJarniou, Catherine, 2013, Le grand livre de l'entrepreneur. Dunod, 2013.

- PlaneJean-Michel, 2016, Management des organisations théories, concepts, performances. Dunod, 4ème éd.

- LégerJarniou, Catherine, 2017, Construire son Business Plan. Le grand livre de l'entrepreneur. Dunod,.

- Sion Michel, 2016, Réussir son business Méthodes, outils et astuces plan.Dunod ,4èmeéd.

- Patrick Koenblit, Carole Nicolas, Hélène Lehongre, Construire son projet professionnel, ESF, Editeur 2011.

- Lucie Beauchesne, Anne Riberolles, Bâtir son projet professionnel, L'Etudiant 2002.

- ALBAGLI Claude et HENAULT Georges (1996), La création d'entreprise en Afrique, ed EDICEF/AUPELF ,208 p.