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

ACADEMIC MASTER HARMONIZE

National program

2022 update

Domain	Sector	Speciality
Science And Technologies	***Mechanical Engineering***	***Mechanical construction***

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National Educational Committee for the field of Science and Technology

ماستر أكاديمى
مواءمة

برنامج وطنى

تحيين 2022

الميدان	الفرع	التخصص
علوم وتكنولوجيا	هندسة ميكانيكية	إنشاء ميكانيكي

I–Master's identity sheet

Access conditions

Sector	Harmonized Master	Access licenses to the master's degree	Ranking according to license compatibility	Coefficient assigned to the license
Mechanical Engineering	**Mechanical construction**	Mechanical construction	**1**	**1.00**
		Energy	**2**	**0.80**
		Civil engineering	**3**	**0.70**
		Public works	**3**	**0.70**
		Other licenses in the ST domain	**5**	**0.60**

II – Half-yearly teaching organization sheets of the specialty

Semester 1: Mechanical construction

Teaching unit	Modules	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Evaluation method	
	Titled			**Course**	**T.D.**	**TP**			**Continuous monitoring**	**Exam**
Fundamental EU Code: UEF 1.1.1 Credits: 10 Coefficients: 5	Continuum mechanics	6	3	3:00	1h30		67h30	82h30	40%	60%
	Material resistance Advanced	4	2	1h30	1h30		45:00	55:00	40%	60%
Fundamental EU Code: UEF 1.1.2 Credits: 8 Coefficients: 4	Internal combustion engines	4	2	1h30	1h30		45:00	55:00	40%	60%
	Applied fluid mechanics	4	2	1h30	1h30		45:00	55:00	40%	60%
Methodological EU Code: UEM 1.1 Credits: 9 Coefficients: 5	TP MDF/RDM	2	1			1h30	10:30	27:30	100%	
	Conventional and advanced manufacturing techniques	4	2	1h30		1h30	45:00	55:00	40%	60%
	Automation of industrial systems	3	2	1h30		1h00	37:30	37:30	40%	60%
EU Discovery Code: UED 1.1 Credits: 2 Coefficients: 2	Material of your choice	1	1	1h30			10:30	02:30		100%
	Material of your choice	1	1	1h30			10:30	02:30		100%
Transversal EU Code: UET 1.1 Credits: 1 Coefficients: 1	Technical English and terminology	1	1	1h30			10:30	02:30		100%
Total semester 1		**30**	**17**	**3:00**	**6:00**	**4:00**	**375h00**	**375h00**		

Semester 2: Mechanical construction

Teaching unit	Modules	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Evaluation method	
	Titled			**Course**	**T.D.**	**TP**			**Continuous monitoring**	**Exam**
Fundamental EU Code: UEF 1.2.1 Credits: 10 Coefficients: 5	Finite element method	6	3	3:00	1h30		67h30	82h30	40%	60%
	Advanced structural dynamics	4	2	1h30	1h30		45:00	55:00	40%	60%
Fundamental EU Code: UEF 1.2.2 Credits: 8 Coefficients: 4	Articulated mechanical systems and robotics	4	2	1h30	1h30		45:00	55:00	40%	60%
	Design of mechanical systems	4	2	1h30	1h30		45:00	55:00	40%	60%
Methodological EU Code: UEM 1.2 Credits: 9 Coefficients: 5	TPMethod ofFinished elements	2	1			1h30	10:30	27:30	100%	
	CAD/CAM	3	2	1h30		1h00	37:30	37:30	40%	60%
	Optimization	4	2	1h30		1h30	45:00	55:00	40%	60%
EU Discovery Code: UED 1.2 Credits: 2 Coefficients: 2	Material of your choice	1	1	1h30			10:30	02:30		100%
	Material of your choice	1	1	1h30			10:30	02:30		100%
Transversal EU Code: UET 1.2 Credits: 1 Coefficients: 1	Compliance with standards and rules of ethics and integrity	1	1	1h30			10:30	02:30		100%
Total semester 2		**30**	**17**	**3:00**	**6:00**	**4:00**	**375h00**	**375h00**		

Semester 3: Mechanical construction

Teaching unit	Modules	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Evaluation method	
	Titled			**Course**	**T.D.**	**TP**			**Continuous monitoring**	**Exam**
Fundamental EU Code: UEF 2.1.1 Credits: 10 Coefficients: 5	Materials	4	2	1h30	1h30		45:00	55:00	40%	60%
	Dynamics of rotating machines	4	2	1h30	1h30		45:00	55:00	40%	60%
	Metal frame	2	1	1h30			10:30 p.m.	27:30		100%
Fundamental EU Code: UEF 2.1.2 Credits: 8 Coefficients: 4	Composite materials	4	2	1h30	1h30		45:00	55:00	40%	60%
	Fracture mechanics and fatigue	4	2	1h30	1h30		45:00	55:00	40%	60%
Methodological EU Code: UEM 2.1 Credits: 9 Coefficients: 5	Office methods	4	2	1h30		1h30	45:00	55:00	40%	60%
	Turbomachines	3	2	1h30		1h00	37:30	37:30	40%	60%
	Digital simulation software in mechanics	2	1			1h30	10:30	27:30	100%	
EU Discovery Code: UED 2.1 Credits: 2 Coefficients: 2	Material of your choice	1	1	1h30			10:30	02:30		100%
	Material of your choice	1	1	1h30			10:30	02:30		100%
Transversal EU Code: UET 2.1 Credits: 1 Coefficients: 1	Documentary research and dissertation design	1	1	1h30			10:30	02:30		100%
Total semester 3		**30**	**17**	**3:00**	**6:00**	**4:00**	**375h00**	**375h00**		

Discovery Unit (S1, S2, S3)

1- *Tribology(*)*
2- *Renewable energies (*)*
3- *Health and Safety*
4- *Aeronautics*
5- *Transportation*
6- *Reliability*
7- *quality management*
8- *Collaborative Design(*)*
9- *Theory of solving innovation problems "TRIZ method"(*)*
10- *Movement Transformation Mechanisms and Cams (*)*
11- *Hydraulic and pneumatic systems and devices(*)*
12- *Welding techniques(*)*
13- *Non-destructive testing(*)*
14- *Electronic*
15- *Electrical engineering*

*(*)**Recommended EDUs***

Semester 4

This semester is devoted to carrying out the end of the master's cycle project. It is carried out in a company or in a research laboratory (university or research center). It is sanctioned by a dissertation and a defense.

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

This table is given for information purposes only.

Evaluation of the End of Master Cycle Project

- Scientific value (jury assessment) /6
- Writing of the dissertation (jury assessment) /4
- Presentation and response to questions (Jury assessment) /4
- Appreciation of the supervisor /3
- Presentation of the internship report (Jury assessment) /3

III - Detailed program by subject for the S1 semester

Semester: 1
Teaching unit: UEF 1.1.1
Subject: Mechanics of continuous media
VHS: 67 hours 30 minutes (Class: 3 hours, tutorial: 1 hour 30 minutes)
Credits: 6
Coefficient: 3

Teaching objectives:

The objective of continuum mechanics is to analyze the movement of a body or a material object. The continuity of the domain is defined mathematically by continuous functions characterizing the domain. We are interested in material domains undergoing continuous transformation. Particular attention is given to areas with solid body behaviors. Continuous transformations of the domain generate strain and stress tensors, which are linked by behavioral laws. The ambition of this course is to teach students the theoretical foundations and methodological precepts, allowing them to analytically resolve certain linear elasticity problems. To simplify the course it is recommended to use index notation.

Recommended prior knowledge:

Rational mechanics, Materials sciences, TP Resistance of materials,Linear algebra, Matrix calculus, Differential equations,Elasticity and Resistance of materials,

Content of the material:

Chapter I: Introduction to the mechanics of continuous media **(1 week)**

Chapter II: Tensor calculation and index notation (2 weeks)

II-1 Tensors

II-2 Index notation: sum convention, free index, silent index, Kronecker symbol, permutation symbol.

II-3 Tensor field and differentiation of a tensor field: differentiation of a vector, gradient of a scalar, divergence and rotational of a vector, Laplacian of a scalar, gradient of a vector and divergence of a matrix.

II-4 Integral theorems of Gauss and Stokes

Chapter III:Strain tensor **(2 weeks)**

III-1 The movement and its representations

III-2 Deformation of a continuous medium: concept of deformation,Definition of the deformation operator, deformation tensor.

III- 3 Invariants of the deformation tensor

III-4 Compatibility equations

Chapter IV: Stress tensor (3 weeks)

IV-1 Stress tensor and invariants

IV-2 Equilibrium equation and symmetry of the stress tensor

IV-3 Normal stress and tangential stress

IV-4 Main directions and main constraints

IV-5 Mohr's Tricircles

IV-6 Special cases of the stress tensor

Chapter V: Constitutive laws in linear elastic **(2 weeks)**

V-1 General form of the law of behavior of an isotropic homogeneous elastic material

V-2 Mechanical characteristics of some isotropic materials

Chapter VI- Deformation energy and resistance criteria (1 week)

VI-1 Deformation energy

VI-2 Resistance criterion: Problem position, Von Mises criterion, Tresca criterion

Chapter VII- Solving linear elasticity problems (4 weeks)

VII- 1- Resolutions using the displacement method (Navier equations).

VII- 2- Examples of problem solving using the displacement method: twisting of a cylinder, thick cylinder subjected to pressure.

VII- 3- Resolution by the constraint method (Beltrami method).

VII - 4- Plane elasticity and Airy functions.

VII - 5- Plane elasticity in polar coordinates

VII -6- Examples of solving elasticity problems using the Airy function.

Evaluation method:

Continuous monitoring: 40%; exam: 60%.

Bibliographic references:

1. *Mechanics of continuous media - Volume 1 - General concepts by Jean Salençon, Edition Ecole Polytechnique de Paris, (2005).*
2. *Mechanics of continuous media - Volume 2 - Thermoelasticity by Jean Salençon, Edition Ecole Polytechnique de Paris, (2002).*
3. *Mechanics of continuous media - Volume 3 - Curvilinear media by Jean Salençon, Edition Ecole Polytechnique de Paris, (2002).*
4. *Mechanics of continuous media, by P. Germain, Editions Masson, Paris (1983)*
5. *Theory of elasticity, by S. Timoshenko and JMGoodier, Librairie Polytechnique Ch. Béranger, 1961*
6. *Mechanics of continuous media - 4th edition: Courses and corrected exercises, byJean Coirierand Carole Nadot-Martin, Edition Dunod, 2013*
7. *Mathematical and mechanical modeling of continuous media, By Roger Temam and Alain Miranville, Edition Scopos, Springer.*
8. *Mechanics of continuous media, byG. Duvaut, Edition Masson, 1990*
9. *Introduction to the mechanics of continuous media, byPaul GermainAndPatrick Muller, Edition Masson, 1995*
10. *Mechanics of continuous media: an introduction, By John Botsis and Michel Deville, Presses Polytechniques et Universitaires Romandes*

Semester: 1
Teaching unit :UEF 1.1.1
Matter :Advanced material strength
VHS: 45 hours (Class: 1:30 a.m., tutorial: 1:30 a.m.)
Credits: 4
Coefficient: 2

Teaching objectives:
Address advanced concepts of material resistance.

Recommended prior knowledge:
RDM 1,RDM2, Rational mechanics, materials science, Mathematics.

Content of the material:

Chapter 1 : Reminder on the calculation of stresses in the case of deflected bending**(2 weeks)Chapter 2 :**Study of the instability of beams (Buckling of beams) **(3 weeks)**
Chapter 3: Resolution of hyperstatic systems using the force method**(3 weeks)**
Chapter 4: Theories of limit stress states **(2 weeks)**
Chapter 5: Thin plates and shells **(2 weeks)**
Chapter 6: Calculation of elements outside the elastic limit **(2 weeks)**
Chapter 7: Resistance under cyclic stresses **(1 week)**

Evaluation method:
Continuous monitoring :40% (presentation. Home work (solving tutorial exercises).
Exam :60%.

Bibliographic references:

1- *Resistance of materials, V. Feodossiev Edition MIR 1971.*
2- *Strength of Materials, William A. Nash; McGraw-Hill 1983.*
3- *A. Giet; L. Geminard. "Resistance of materials", Editions Dunod 1986, Paris.*
4- *Mr. Albiges; A Corner. "Resistance of materials", Editions Eyrolles 1986; Paris.*
5- *Jean-Claude Doubrère. " Strength of materials», Editions Eyrolles 2013*
6- *Youde Xiong. « Resolved exercises in resistance of materials",EditionsEyrolles, 2014.*
7- *Claude Chèze. "Resistance of materials - Sizing of structures,Simple and compound stresses, buckling, internal energy, hyperstatic systems",Ellipses, 2012.*
8- *Resistance of materials, P. STEPINE, Editions MIR; Moscow, 1986.*
9- *Montagner R., Course on resistance of materials, 12th Edition 1988, Editions Eyrolles.*
10- *Timoshenko S. Resistance of materials – Volume 1: Elementary theory and problems. 3rd Ed. Dunod, Paris, 1968, 420p.*
11- *Timoshenko S. Resistance of materials–Volume 2: Developed theory and problems, Dunod, Paris, 1968. 3rd Ed. Dunod, Paris, 1968, 464p.*
12- *N. Bourahla, resistance of basic materials, GECOTEC, 2013*.

Semester: 1
Teaching unit: UEF1.1.2
Matter :Internal combustion engines
VHS: 45h (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Provide an analytical description of the operation of internal combustion engines as well as the principles of calculating their performance and basic sizing.
Develop the ability to integrate all the disciplines of mechanics to structure the description of internal combustion engines, to master their conceptual aspects and to model their behavior.

Recommended prior knowledge:

Knowledge of applied thermodynamics and combustion
Knowledge of machine kinematics and dynamics

Content of the material:

First part :Organic, thermodynamic and general mechanics analysis
Chapter 1 : Functional main and auxiliary drivelines **(3 weeks)**
Chapter 2 : New techniques and improvement in engine performance (2 weeks)
- 1-1 Undersizing
- 1-2 Variable distribution
- 1-3 Variable compression ratio
- 1-4 Miller-Atkinson cycle
- 1-5 Stratified load
- 1-6 HCCI concept
- 1-7 PCCI Concept

Chapter 3: Respirations: operating methods, aspiration and supercharging**(2 weeks)**
Chapter 4: Friction, general architecture, main dimensions **(2 weeks)**

Second part :Implementation of fuels
Chapter 5: Combustibility properties and study of combustion modes**(2 weeks)**
Chapter 6: Studies of anomalies and optimization of combustion laws**(2 weeks)**
Chapter 7: Power technologies and control of polluting emissions**(2 weeks)**

Evaluation method:

Continuous monitoring :40%,Exam :60%.

Bibliographic references:

1. *JB Heywood, "Internal Combustion Fundamentals", McGraw Hill Higher Education, 1989.*
2. *P. Arquès, "Design and construction of alternative engines:From theory to competition», Ellipse, 2000.*
3. *JC. Guibet, "Fuels and engines", 1997.*
4. *P. Arquès, "Reciprocating internal combustion engines (Technology)", Masson edition, 1987.*
5. *UY FaminGorban, AI, Dobrovolsky VV, Lukin AI et al., "Marine internal combustion engines", Leningrad:Sudostrojenij, 1989, 344p.*

6. *W. Diamant, "Internal combustion engines", ECAM, 1984.*
7. *M. Desbois, R. Armao, "The diesel engine, Edition Foucher", Paris, 1974.*
8. *M. Menardon, D. Jolivet, "Motors, Edition Chotard", Paris, 1986.*
9. *M. Desbois, "The automobile: T1: 4-stroke and two-stroke engines. T2: The organs of transmission and use", Edition Chotard, 1989.*
10. *P. Arques, "Combustion", Ellipses, Paris, 1987.*
11. *H. Memetau, "Functional techniques of the automobile: The engine and its auxiliaries", Dunod, Paris, 2002.*
12. *Allan T. Kirkpatrick, "Internal Combustion Engines-Applied Thermosciences", Third edition, Fourth edition, Wiley, 2021.*
13. *Colin R. Ferguson, Allan T. Kirkpatrick, "Internal Combustion Engines-Applied Thermosciences", Third edition, Wiley, 2016.*
14. *A. Bechkok, "Internal combustion engines: For the use of students in the 4th year of Mechanical Engineering", Edition Office des publications universitaire, Algiers, 1995.*
15. *Willard W. Pulkrabek, "Engineering Fundamentals of the internal combustion engine", Second edition, Prentice Hall, 2003.*
16. *Willard W. Pulkrabek, "Solutions Manual for Engineering Fundamentals of the Internal Combustion Engine», Second edition, Prentice Hall, 2003.*
17. Guibet,"Fuels and engines: Technologies, Energy, Environment",Volume 1, Technip, 1997.

Semester: 1
Teaching unit :UEF 1.1.2
Matter :Applied fluid mechanics
VHS: 45 hours (Class: 1:30 a.m., tutorial: 1:30 a.m.)
Credits: 4
Semester: 2

Teaching objectives:

Acquire the necessary knowledge of fluid mechanics such as the main conservation laws in order to adapt them to the concerns of experimenters and engineers/designers: calculation & sizing of structures, organs and distribution networks of renewable energy systems. Additional technical knowledge in fluid mechanics applied to hydraulic networks

Recommended prior knowledge:

Basic fluid mechanics.
Develop expertise in the field of analytical and numerical methods in order to understand and use advanced concepts in fluid mechanics.
Work on analytical and numerical resolution (with the help of commercial software) allows for a better understanding of the theoretical material. Synthesis project.

Material content:

Chapter 1: Reminders on fluid statics (case of tanks and storage enclosures) **(1 week)**
Chapter 2 : Concept of Fluid Dynamics (recall of equations without demonstration) **(1 week)**
Chapter 3: Flow regimes of primary and secondary fluids **(2 weeks)**
Chapter 4: Application of conservation laws (mass, momentum and energy) to these regimes (cases of typical problems) **(3 weeks)**
Chapter 5: Flow in pipes (introduction of FANNO and REILEY) **(3 weeks)**
Chapter 6: Calculation of distribution networks and operating point of a system thermodynamics **(3 weeks)**
Chapter 8: Hydrodynamic lubrication **(2 weeks)**

Evaluation method:

Continuous monitoring: 40%; Examination: 60%.

Bibliographic references:

1. *Multiphase thermohydraulics, course document, G. BERTHOUD, ENSPG – France, 1993.*
2. *Boiling condensation and gas–liquid flow, PB WHALLEY, Oxford, 1987.*
3. *Multiphase Flow Dynamics, Kaviany, Maasoud, 1- Fundamentals.*
4. *Multiphase Flow Dynamics,Kaviany, M., 2- Thermal and Mechanical Interactions.*

Semester: 1
Teaching unit: UEM 1.1
Matter :TPMDF/RDM
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:
Practically illustrate the knowledge acquired in the Strength of Materials / Fluid Mechanics course.

Recommended prior knowledge:
MDF, Material strength.

Content of the material:according to existing means

TP MDF

1. Flow measurement
2. viscosity
3. Study of the Center of Thrust
4. Fluid Statics
5. flow around an obstacle
6. Impulse of a jet
7. Load losses and speed profiles
8. Study of the influence of the pressure field on a hydrodynamic bearing
9. Effect of inclination of a plane shoe on pressure distribution

TP RDM

1. Triangulated beam
2. Transverse displacements in a beam - Bending
3. Bending Moments & Normal Stresses - Bending
4. Buckling
5. Hyperstatic systems
6. Others….

Evaluation method: ControlContinuous: 100%.

Bibliographic references:

Semester: 1
Teaching unit: UEM 1.1
Matter :Conventional and advanced manufacturing techniques
VHS: 45h (Class: 1h30, TP: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
The objective of this teaching is to help the student learn the different processes for obtaining parts.
Open to the student another horizon of techniques which are necessary for the shaping of particular parts.

Recommended prior knowledge:
Industrial design, general mechanics
Content of the material:
Part I

1. Introduction
2. Foundry
3. Mshaped by plastic deformation
4. Forming flat products
5. Machining

Part II

1. electroerosion
2. Sintering.
3. Photochemical machining.
4. Laser machining.
5. Explosion forming,
6. Electro-hydraulic forming.
7. Electromagnetic forming.

Evaluation method:
Continuous monitoring :40%,Exam :60%.

Bibliographic references:

1. *Claude Corbet, Mémotech - Material shaping processes, Editor(s):Casteilla, Collection :Mémotech, 2005.*
2. *M. Ashby, Y. Bréchet, L. Salvo, selection of materials and implementation processes, Vol. 20 of the Treatise on Materials, Polytechnic and University Presses Romandes, 2001.*
3. *Eric FELDER, Shaping of metals - Mechanical and thermal aspects, Engineering Techniques, Reference M3000 v2, 2015.*
4. *Éric FELDER, Lubrication in shaping - General principles and choices, Engineering Techniques, Reference M3015 v1, 2006.*
5. *SUÉRY Michel, Shaping of metal alloys in the semi-solid state, Hermes, Lavoisier, 2002.*
6. *Battaglia Jean-Luc, Thermal transfers in materials shaping processes: corrected lessons and exercises,Paris Hermes science publ. 2007 Lavoisier.*

7. *L. Rimbaud, G. Layes, J. Moulin, Practical Guide to Machining, Hachette Technique, 2006.*
8. *J. SAINT-CHELY, "choice of tools and cutting conditions during turning", 1993.*
9. *Pierre Bourdet. Metal cutting. Course Ecole Normale Supérieure de Cachan, Ver 5 2004*
10. *J. Jacob, Y. Malesson, D. Ricque, Practical guide to machining 2: Turning, Hachette Techniques.*
11. *François BAGUR, Materials for cutting tools, Engineering Techniques, Reference BM7080 v1, 1999.*
12. *Eric FELDER, Modeling of metal cutting, Engineering Techniques, Reference BM7041 v1, 2006.*

Semester: 1
Teaching unit: UEM 1.1
Matter :Automation of industrial systems
VHS: 37h30 (Class: 1h30, TP: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives:

The assimilation of fundamental knowledge in the field of automation, and the acquisition of the concepts necessary for controlling industrial processes. In general it is knowingdefine and implement the control rules of a system based on knowledge of the dynamic behavior of the process to be automated and the objectives to be achieved.

Recommended prior knowledge:

Mathematics, regulation, mechanical construction, electricity…..

Content of the material:

Chapter 1 : Introduction, control systems, supervision systems, ManufacturingExecution**202020**System (MES).
(2 weeks)

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

- Introduction
- Purpose of Industrial Systems Automation
- Profitability of an automation
- Life cycle of an industrial system
- Modular design
- Implementation

Chapter 3: Supervision systems **(4 weeks)**

- Role of a supervision system
- Design of supervision applications

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

- role of a automaton, principles of programmable logic,
- principle of the programmable controller,

Production technology

- virtual programmable controllers (Soft PLC)

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

Evaluation method:

Continuous monitoring :40%,Exam :60%.

Bibliographic references:

1- *Henri Bourles. "Linear systems from modeling to control". Editions Lavoisier 2006, Paris.*
2- *Jean Marie Flans. "Industrial regulation". Hermes 1994; Paris.*
3- *Philippe de Larminat. "Automatic control of linear systems". Editions Hermès 1996; Paris*
4- *Patrick Prouvost. "Automatic – Control and regulation", Edition Dunod 2010.*

5- *Yves GRANJON. " Automatic ". Edition Dunod 2010*
6- *Olivier Le Gallo. "Automatics of mechanical systems". Edition Dunod, 2009.*
7- *Gérard Boujat, Patrick Anaya. "Industrial automation", Edition Dunod, 2007.*
8- *JANET Maurice. "Precis of matrix calculation and operational calculation", Edition Euclid 1982.*
9- *Patrick Prouvost. "Automatic – Control and regulation". Edition Dunod, 2010.*

Semester: 1
Teaching unit: UED 1.1
Matter :Subject 1 of your choice
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Semester: 1
Teaching unit: UED 1.1
Matter :Subject 2 of your choice
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Semester: 1
Teaching unit: UET 1.1
Subject 1:Technical English and terminology
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Introduce the student to technical vocabulary. Strengthen your knowledge of the language. Help him atunderstand and synthesize a technical document. Allow him to understand a conversation in English held in a scientific framework.

Recommended prior knowledge:
Basic English vocabulary and grammar

Material content:

- Written comprehension :Reading and analysis of texts relating to the specialty.
- Oral comprehension: Using authentic popular science video documents,note taking, summary and presentation of the document.
- Oral expression: Presentation of a scientific or technical subject,development and exchange of oral messages (ideas and data), Telephone communication, Gestural expression.
- Written expression :Extraction of ideas from a scientific document, Writing a scientific message, Exchange of information in writing,writing CVs, application letters for internships or jobs.

Recommendation :It is strongly recommended that the person responsible for the subject presents and explains at the end of each session (at most) around ten technical words of the specialty in the three languages (if possible) English, French and Arabic.

Evaluation method:
Review: 100%.

Bibliographic references:

1. *PT Danison, Practical guide to writing in English: uses and rules, practical advice, Editions d'Organization 2007*
2. *A.Chamberlain, R. Steele, Practical guide to communication: English, Didier 1992*
3. *R. Ernst, Dictionary of applied techniques and sciences: French-English, Dunod 2002.*
4. *J. Comfort, S. Hick, and A. Savage, Basic Technical English, Oxford University Press, 1980*
5. *EH Glendinning and N. Glendinning, Oxford English for Electrical and Mechanical Engineering, Oxford University Press 1995*
6. *TN Huckin, and AL Olsen, Technical writing and professional communication for nonnative speakers of English, McGraw-Hill 1991*
7. *J. Orasanu, Reading Comprehension from Research to Practice, Erlbaum Associates 1986*

IV - Detailed program by subject for the S2 semester

Semester: 2
Teaching unit: UEF 1.2.1
Matter :Finite element method
VHS: 67h30 (Class: 3h00, tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:

Present the finite element method and modern solution methods for dealing with linear and nonlinear problems, one- and two-dimensional field problems, nonstationary field problems, and solid mechanics problems

It is primarily aimed at students who want to develop comprehensive skills in finite element methodology, from fundamental concepts to practical computer implementations.

Recommended prior knowledge:

Notions in: Mechanics of Continuous Media, Variational Formulation, Matrix Calculus, Differential Calculus, Numerical Analysis.

Content of the material:

Chapter 1: Basic Concepts (2 weeks)

1-Introduction to the finite element method
2- Deformation energy.
3- Matrix analysis methods
4- Principle of virtual work
5-Variational Principle
6- Galerkin method (Weighted residuals)

Chapter 2: Linear structural elements (4 weeks)

1- Linear and spiral spring elements.
2- Elastic Bar Elements
3- Trellis systems
4- Beam Elements

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

1- Introduction
2- Plane stresses, plane strains and stress-strain relationships
3- Triangular and rectangular plane elements (of order 1: T3 and Q4 and of high order: T6 and Q8)
4- Isoparametric formulation of the quadrilateral element
5- Elements for plate bending (ACM, R4)

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

1- Introduction
2- Tetrahedral Elements (4, 10 and 20 nodes)
3- Solid Elements (8 node bricks)
4- Isoparametric formulation of volume elements
5- Analysis of three-dimensional structures using planar elements.
6- Solid of revolution (Axisymmetric)

Chapter 6- Additional formulations (3weeks)

1. Finite element techniques
   - Mesh Design
   - Distortion
   - How to choose a mesh
   - Convergence
2. Hardware nonlinearity
   - Elastoplasticity
   - Elastoplastic behavior
   - Solving techniques
3. Thermal issues

Evaluation method:

Continuous monitoring: 40%; Exam: 60%.

Bibliographic references:

1. *JF Imbert, "Analysis of Structures by Finite Elements", Cepadues, 3rd Ed., 1991.*
2. *Jean-Louis Batoz, Gouri Dhatt, "Modeling of Structures by Finite Elements, Volume 1: Elastic Solids", Hermès Sciences Publication 1990.*
3. *Jean-Louis Batoz, Gouri Dhatt, "Modeling of Structures by Finite Elements, Volume 2: Beams & Plates", Hermès Sciences Publication 1990.*
4. *Jean-Louis Batoz, "Modeling of Structures by Finite Elements, Volume 3: Shells", Hermès Sciences Publication 1992.*
5. *OCZienkiewicz, "The Finite Element Method", Mc Graw Hill, 1979.*
6. *Understanding finite elements (Principles, formulation and corrected exercises)*
7. *Rahmani O and Kebdani S., Introduction to the finite element method for engineers, 2nd ed. OPU, 1994.*
8. *Paul Louis George, "Automatic Generation of Meshes: Applications to Finite Element Methods", Dunod, 1990.*
9. *C. ZienkiewiczAnd RL Taylor, "The Finite Element Method For Solid And Structural Mechanics", Sixth Edition By O. Butterworth-Heinemann 2005.*
10. *AlaaChateauneuf, "Understanding Finite Elements: Structures. Principles, Formulations and Corrected Exercises", Ellipses Marketing, July 2005.*

Semester: 2
Teaching unit: UEF 1.2.1
Matter :Dynamics of structuresadvances
VHS: 45h00 (Class: 1h30, tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

This course aims to determine and resolve the equation of motion of structures (free, forced, damped undamped, etc.). Knowledge of the different responses due to different loadings informs us about the vibration modes and the possibilities of their damping.

Recommended prior knowledge:

Knowledge is necessary in solid dynamics, analytical mechanics, vibration and waves and resistance of materials.

Content of the material:

Chapter 1 Reminders of kinetics, dynamics (2 weeks)

Moment and Tensor of inertia of a material assembly and common geometries. Huygens-Koenigs theorem. Kinematic-kinetic-dynamic torso- Kinetic energy. Fundamental Principle of Dynamics, Theorems of momentum, angular momentum and kinetic energy. Principle of virtual works, Lagrange equation of 1st and 2nd kind, Hamilton principle.

Chapter II: Systems with one degree of freedom (2 weeks)

II.1. Free undamped oscillations
II.2. The stiffness coefficient of some systems
II.3. Free damped oscillations
II.4. Applications

Chapter III: Forced oscillations of 1DOF systems (2 weeks)

III.1. General
III.2. Forced oscillations due to harmonic loading
III.3. Forced oscillations due to impulsive half-sine loading
III.4. Forced oscillations due to Spectral loading - DUHAMEL integral
III.5. Forced oscillations due to random loading

Chapter IV: Vibrations of continuous systems (3 weeks)

IV.1. Reminders on systems with several degrees of freedom.
IV.2. String vibrations.
IV.3. Vibrations of the beams.
IV.4. Membrane vibrations.

Chapter V: Variational methods for characterizing eigenvalues. (3 weeks)

V.1.The Rayleigh quotient
V.2.Iterative search for modes and eigenvalues
V.3.Applications - Approximation of continuous systems (pendulums - beams in pure bending)

Chapter VINumerical methods applied to structural dynamics (3 weeks)

VI.1. The finite element method in beam dynamics
VI.2. Variational formulation of free vibrations in bending
VI.3. Calculations of free vibrations by finite elements

Evaluation method:

Continuous monitoring: 40%; Exam: 60%.

Bibliographic references:

1. *Theory of Vibrations, S. Timoshnko.*
2. *Theory of Vibrations, Application to structural dynamics, M. Géradin.*
3. *Dynamics of structuresPatrick PaultreHermès - Lavoisier.*
4. *Dynamics of structures: Numerical modal analysis ofThomas GmürPublisher: Presses Polytechniques et Universitaires Romandes.*
5. *Dynamics of structures, Volume 1, Principles and fundamentals, RWCLOUGH and J. PENZIEN.*
6. *Dynamics of structures: Numerical modal analysis,Thomas Gmür, Publisher: Presses Polytechniques et Universitaires Romandes.*

Semester: 2
Teaching unit: UEF1.2.2
Matter :Articulated mechanical systems and robotics
VHS: 45h (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
Be able to model a simple mechanism as a system of rigid, non-deformable solid bodies, be able to solve the associated statics, kinematics and dynamics problems.

Recommended prior knowledge:
Basic knowledge in solid mechanics, kinetics and dynamics of rigid bodies, theory of mechanisms and torsors.

Material content:
Chapter I: Introduction to robotics **(1 weeks)**
(Definitions, Terminology, Types of architectures: Serial robots, Parallel robots, mobile robots, flexible robots, walking robots Etc...)

Chapter II: Parameterization of a solid and a chain of solids in space**(2 weeks)**

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

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

Chapter V: Dynamic modeling (Lagrange formalism, Newton's formalism-Euler) **(3 weeks)**

Chapter VI: Movement generation **(2 weeks)**

Chapter VII: Introduction to medical and assistance robotics for people with reduced mobility **(2 weeks)**

Mini-project : Modelizationof a robotfor a specific task, determination of the workspace and optimal placement of a robot. (Work from home 21 days)

Or

Practical work: Programming a robot (point tasks, continuous tasks, pick and place)

Evaluation method:
Continuous monitoring :40%,Exam :60%.

Bibliographic references:

1. *Modeling, identification and control of robots, Wisama Khalil and Etienne Dombre; Herrmes Lavoisier 1999.*
2. *Theory of perfect mechanisms: design tools author(s): leroyLavoisier 1998.*
3. *Simplified theory of elementary mechanismsauthor :loach l.-e.Dunod 2001.*
4. *JP Lellmendet SaidZeghloul " Robotics fundamental aspects Masson1991.*
5. *Theory of perfect mechanisms: design tools author(s): leroyLavoisier 1998.*
6. *A. Pruski General robotics. Ellipses 1988.*

7. *P. André Treatise on robotics T4: Technological constituents. Hermes 1986.*
8. *M. Cazin and J. Metje Mechanics of robotics Dunod1989.*
9. *Jack Guittet Medical robotics. Hermes1998.*
10. *Saeed Benjamin Niku, "Introduction to robotics - analysis, control, applications", second edition, Wiley, 2011.*
11. *John J. Craig,"Introduction to Robotics – Mechanics and control", Pearson, 2005.*
12. *Reza N. lazar,"Theory of Applied Robotics - Kinematics, Dynamics, and Control", Library of Congress, 2007.*

Semester: 2
Teaching unit :UEF 1.2.2
Matter :Design of mechanical systems
VHS: 45 hours (Class: 1:30, TD: 1:30)
Credits: 4
Coefficient: 2

Teaching objectives:

Know the general approach to designing a new product or improving an existing product. Apply creativity tools for group design work. Sizing mechanisms. Deepen technological knowledge of certain mechanical systems.

Recommended prior knowledge:

RDM, Mechanisms, machine elements.

Content of the material:

Chapter 1. The quality approach (1 week)

Definition, certification and organizations, standards.

Chapter 2. The functional specifications (2 weeks)

(Definition, expression of need, criterion, wording).

Chapter 3. Functional analysis approach (3 weeks)

Definition, formulation of functions (main, complementary and technical), constraints, value analysis approach.

Chapter 4. Applications (4 weeks)

Application to the kinematic chain of a mechanism (of a vehicle, of a machine tool, of a lifting machine)

Chapter 5. Computer-Aided Mechanical Design (CMAO) (5 weeks)

Calculations applied to power transmission elements (gears, belts and chains). Plain and rolling bearings, thrust bearings.,

Evaluation method:

Continuous monitoring :40%,Exam :60%.

Bibliographic references:

1. Alain Pouget, Thierry Berthomieu, Yves Boutron, Emmanuel Cuenot, “Structures and mechanisms - Mechanical construction activities”, Ed. Hachette Technique.
2. YOUSEF HAIK, Tamer Shahin, “Engineering Design Process”, Ed. Engage Learning, 2011.
3. KEN HURST, “Engineering Design Principles”, Ed. Elsevier Science and Technology Books, 1999.
4. JAMES ARMSTRONG, "Design Matter -The Organization and Principles of EngineeringDesign-", Ed. Springer -Verlag London Limited, 2008.
5. DELAFOLLIE G., “Analysis of value”, Ed. Hachette, Paris, 1991.
6. DUCHAMP F., “The design of new products”, Ed. Hermès, Paris, 1998.

7. ROBERT C. JUVINALL, KURT M. MARSHEK, "Fundamentals of Machine ComponentDesign", Ed. John Wiley&Sounds, 2012.
8. GEORGES SPINNLER, "Design of machines - Principles and applications -", T1, T2 and T3, Ed. Presses polytechniques et universitaire romandes, 2002.
9. ROBERT L. NORTON, “Machine Design -An Integrated Approach-”, Ed. PEARSON Prentice Hall, 2006.
10. R. Quatremer, JP Trotignon, M. Dejans, H. Lehu, “Precis de Construction Mécanique”, Volume 1, Study projects, components, standardization, Afnor, Nathan 2001.
11. R. Quatremer, JP Trotignon, M. Dejans, H. Lehu. “Precis de Construction Mécanique”, Volume 3, Projects-calculations, sizing, standardization, Afnor, Nathan 1997.
12. Francis Esnault, “Mechanical construction, Power transmission”, Volume 1, Principles and Ecodesign, Dunod, 2009.
13. Francis Esnault, “Mechanical construction, Power transmission”, Volume 2, Applications, Dunod, 2001.
14. Francis Esnault, “Mechanical construction, Power transmission”, Volume 3, Power transmission by flexible links, Dunod, 1999.
15. M. Szwarcman, “Elements of machines”, Lavoisier edition 1983W. L. Cleghorn, “Mechanics of machines”, Oxford University Press, 2008.

Semester: 2
Teaching unit: UEM 1.2
Matter :TP Finite elements
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:
Know how to model and simulate using finite element software or calculation code.

Recommended prior knowledge:
Wording andFinite element calculation

Content of the material:

1- Practical work on springs; bars, beam
2- Practical work on plane elements
- Analytical formulation of elements Q4, T3, by Scientific mathematical software and determination of the elementary rigidity matrix as well as the assembly of these matrices.
- Modeling of beams in 2 D using Plan Q4 and T3 elements on software (Abaqus, Ansys, RDM6, etc.) and comparison with existing analytical solutions.

3- Practical work with software (Abaqus, Ansys, etc.) on axisymmetric elements (cylinder under internal pressure)
4- Practical work with Software (Abaqus, Ansys, etc.) on Vibration of beams modeled by membrane elements (Example CPS4 and CPS3 of the Abaqus code) and of plates modeled by plate elements (Example S4R of the Abaqus code).
5- Thermal transfer practical work on calculation code (Abaqus, Ansys, etc.).
6- Practical work with software (Abaqus, Ansys, etc.) on plastic calculation of two- and three-dimensional structures.
7- Programming by Fortran or Matlab of the elements Q4, T3, Bar and Beam.

Evaluation method:
Continuous Control: 100%

Bibliographic references:

1. *JF Imbert, "Analysis of Structures by Finite Elements", Cepadues, 3rd Ed., 1991.*
2. *Jean-Louis Batoz, Gouri Dhatt, "Modeling of Finite Element Structures, Volume 1: Elastic Solids", Hermès Sciences Publication 1990.*
3. *Jean-Louis Batoz, Gouri Dhatt, "Modeling of Finite Element Structures, Volume 2: Beams & Plates", Hermès Sciences Publication 1990.*
4. *Jean-Louis Batoz, "Modeling of Finite Element Structures, Volume 3: Shells", Hermès Sciences Publication 1992.*
5. *OCZienkiewicz, "The Finite Element Method", McGraw Hill, 1979.*
6. *Understanding finite elements (Principles, formulation and corrected exercises)*
7. *Rahmani O and Kebdani S., Introduction to the finite element method for engineers, 2nd ed. OPU, 1994.*
8. *D. Ouinas "Application of the finite element method for the use of engineers, courses and corrected exercises". Volume 1-OPU 2012.*

9. *Paul Louis George, "Automatic Generation of Meshes: Applications to Finite Element Methods", Dunod, 1990.*
10. *C. Zienkiewiczand RL Taylor, "The Finite Element Method for Solid and Structural Mechanics", Sixth Edition by O. Butterworth-Heinemann 2005.*
11. *AlaaChateauneuf, "Understanding Finite Elements: Structures. Principles, Formulations and Corrected Exercises", Ellipses Marketing, July 2005.*

Semester: 2
Teaching unit: UEM 1.2
Matter:CAD/CAD/CAM
VHS: 37h30 (Class 1h30, practical work: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives:

The aim is to improve students' knowledge in the field of CAD/CAM. At the end of the semester, the student will have to acquire the following skills:

- Modeling of parts with complex shapes (molds, matrices, etc.).
- Simulation of the machining process.
- Interpretation and verification of the automatically generated machining program.

During the practical sessions, the student will have to master CAD/CAM software to design complex parts and assemblies as well as to simulate the machining of the designed parts. If existing resources allow it, the student must go to the workshop to execute the program generated on a numerically controlled machine tool (MOCN).

Recommended prior knowledge:

Mathematics, CAD, CAD concepts and mechanical manufacturing (conventional machining).

Content of the material:

Chapter 1. General: (3 weeks)

CAD system and modeling of curves, surfaces and solids.

Chapter 2. The (MOCN) (1 week)

Introduction, main bodies, areas of use, standardized axes, origins, control of an axis, different architectures of MOCNs.

Chapter 3. Programming of MOCN: (5 weeks)

Description of the different programming methods: Manual, assisted and automatic programming.

ISO programming: Introduction, structure of a NC program, main preparatory functions, main auxiliary functions, cutting parameters, predefined cycles, examples.

Chapter 4. CAM Software: (4 weeks)

Use of CAM software (e.g. CamWorks, Mastercam or others), generation and simulation of the tool path, generation of the file in G code languages and transmission to the machine**.**

Chapter 5. Basics of rapid prototyping and 3d printing (2 weeks)

The practical sessions: must take place in a room equipped with microcomputers on which either CAD/CAM software or CAD software and another CAM software are installed. The practical work must be divided into two parts:

CAD part: (3 weeks)

- Production of parts with complex shapes (use of functions and surface tools).
- Making an assemblyand drawing (cartridge, nomenclature, annotations, characteristics, mass of parts).
- Static simulation (rapid calculation of stresses and strainsand safety factor).

FAO part: (9 weeks)

Simulation of part machining using the following steps(following the steps of the chosen CAM software) in the majority of cases:

- Plan a project for a part already designed under the CAD system.
- Choice of machine (depending on the shape of the project part).
- Repository selection.
- Raw selection.
- Choosing a safety plan and removing the tool.
- Selection of surfaces and shapes to be machined (example: drilling, facing, contouring, pocketing, etc.).
- Choice of tools and cutting conditions from the CAM software database.
- Execution of the simulation (generation of tool paths).
- Intervention on the order of operations generated by the simulation,
- Parameterization and adjustment of each operation (if necessary).
- Choice of post-processor.
- Generation of the machining program in G-code.
- Reading and checking the generated program.
- Transmission of the program to the machine and machining.

For the CAM part, it is necessary to start with parts of simple shapes (prismatic and cylindrical) in order to experience the effect of the variation of the different parameters chosen (variation of cutting conditions, machining strategies, cutting tools , radial and axial passes, approach and retreat macros, etc.); checking the generated machining program will also be easier. Subsequently, parts with complex shapes can then be processed without difficulty. If available means allow it, it would be very beneficial to run the generated program on a MOCN.

The time allocated being very limited, a large part of the work will have to be carried out by the students outside of practical hours.
Propose a mini machining project for groups of students to carry out at home and encourage them to install CAD/CAM software on their personal microcomputers.

Evaluation method:
Continuous monitoring :40%,Exam :60%.

Bibliographic references:

1. JEAN-CLAUDE LEON, "Modeling and construction of surfaces for CAD/CAM",
2. Ed. Hermès, Paris, 1991.
3. GERALD FARIN, “Curves and Surfaces for CAGD”, Ed. Academic Press, 2002.
4. M. HOSAKA, "Modelling of Curves and Surfaces in CAD/CAM", Ed. Springer Verlag, 1992.
5. DAVID F. ROGERS, "An Introduction to NURBS with Historical Perspective", Ed. Academic Press, 2001.
6. KUNWOO LEE, "Principles of CAD/CAM/CAE systems", Ed. Addison Wesley, 1999.
7. IBRAHIM ZEID,“Mastering CAD/CAM”, Ed. McGraw-Hill, 2004.
8. MILTIADIS A. BOBOULOS, “CAD-CAM & Rapid Prototyping Application Evaluation”, Ed. Ventus Publishing Aps, 2010.
9. ALAIN BERNARD, “Computer-assisted manufacturing”, Ed. Lavoisier Hermès-science, Paris, 2003.
10. PETER SMID, “CNC Programming Handbook”, Ed. IndustrialPress Inc., 2007.
11. JEAN VERGNAS, “Operation of numerically controlled machine tools”, Ed. Pyc, 1985.
12. CLAUDE HAZARD, “Numerical control of machine tools”, Ed. Foucher, 1984.
13. CLAUDE MARTY, CLAUDE CASSAGNES, PHILIPPE MARIN, "The practice oforderdigital

machine tools", Ed. Tec & Doc, 1993.
14. A. CORNAND, F. KOLB, “Machining and numerical control”, Ed. Foucher, 1987.
15. P. GONZALEZ, “Numerical control by computer: turning, milling, machining center”, Ed. Casteilla, Paris, 1993.
16. CATIA software documentation, "Catia Lathe Machining", "Catia Prismatic Machining", "Catia Advanced Machining".

Semester: 2
Teaching unit: UEM 1.2
Matter :Optimization
VHS: 45h00 (Class: 1h30, TP: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
Become familiar with operations research models. Learn to formulate and solve optimization problems and master the appropriate techniques and algorithms.

Recommended prior knowledge:
Basic notions of mathematics. Linear algebra.Matrix algebra.

Content of the material:

Chapter I: Linear optimization **(3 weeks)**
- General formulation of a linear program
- Examples of linear programs (Production problem, Mixing problem, Cutting problem, Transport problem)
- Solving the problem using the Simplex method:
    - Basics and basic solutions of linear programs
    - The simplex algorithm
    - Initialization of the simplex algorithm (the two-phase method).

Chapter II: Non-linear optimization without constraint **(5 weeks)**
- Positivity, Convexity, Minimum
- Gradient and Hessian
- Necessary conditions for a minimum
- Sufficient conditions for a minimum
- Local methods
- One-dimensional search methods
- Gradient methods
- Methods of conjugate directions
- Newton's method
- Quasi-Newton methods

Chapter III: Nonlinear optimization with constraints **(4 weeks)**
- Lagrange multipliers
- Karush-Kuhn-Tucker Terms
- Penalty method
- Sequential quadratic programming

Chapter IV: Stochastic optimization methods **(3 weeks)**
- The genetic algorithm
- The particle swarm method

Organization of practical work: it is preferable that the TPs are direct applications in the field of mechanical construction.

TP 1: presentation of optimization reference functions in Matlab
TP 2: Presentation of the optimtool optimization tool in matlab
TP 3: Definition and plotting of the curves of some test functions in optimization

TP 4: Solving a linear optimization problem without constraints
TP 5: Solving a linear optimization problem with constraints
TP 6: Nonlinear minimization without constraints
TP 7: Nonlinear minimization without constraints with gradient and Hessian
TP 8: Nonlinear minimization with equality constraints
TP 9: Nonlinear minimization with inequality constraints
TP 10: Minimization with equality and inequality constraints
TP 11: Use of the optimtool or other tool to solve a nonlinear optimization problem with constraints
TP 12: Minimization with constraints using the GA function

Evaluation method:
Continuous monitoring :40%,Exam :60%.

Bibliographic references:

1. *E. Aarts & J. Korst, Simulated annealing and Boltzmann machines: A stochastic approach to combinatorial optimization and neural computing. John Wiley & Sons, New York, 1997.*
2. *D. Bertsekas, Nonlinear programming. Athena Scientific, Belmont, MA, 1999.*
3. *M. Bierlaire, Introduction to differentiable optimization. French-speaking polytechnic and university presses, Lausanne, 2006.*
4. *F. Bonnans, Continuous optimization: courses and corrected problems. Dunod, Paris, 2006.*
5. *F. Bonnans, JC Gilbert, C. Lemaréchal and C. Sagastizàbal, Digital optimization: theoretical and practical aspects. Springer, Berlin, 1997.*
6. *PG Ciarlet, Introduction to matrix numerical analysis and optimization. Masson, Paris, 1994.*
7. *E. Chong and S. Zak, An introduction to optimization. John Wiley & Sons, New York, 1995.*
8. *Y. Colette and P. Siarry, Multiobjective optimization. Eyrolles, Paris, 2002.*
9. *JC Culioli, Introduction to optimization. Ellipses, Paris, 1994.*
10. *J. Dennis & R. Schnabel, Numerical methods for unconstrained optimization and nonlinear equations. Prentice Hall, Englewood Cliffs, NJ, 1983.*
11. *R. Fletcher, Practical methods of optimization. John Wiley & Sons, New York, 1987.*
12. *P. Gill, W. Murray, & M. Wright, Practical optimization. Academic Press, New York, 1987.*

Semester: 2
Teaching unit: UED 1.2
Matter :Subject 1 of your choice
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Semester: 2
Teaching unit: UED 1.2
Matter :Subject 2 of your choice
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Semester: 2
Teaching unit: UET 1.2
Subject: Respect forstandards and rules of ethics and integrity.
VHS: 10:30 p.m. (Class: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:

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

Recommended prior knowledge:

Ethics and professional conduct (the foundations)

Content of the material:

A. The respect of the rulesethics and integrity,

1. **Reminder on the MESRS Charter of Ethics and Professional Conduct:**Integrity and honesty. Academic freedom. Mutual respect. Requirement for scientific truth, objectivity and critical thinking. Equity.Rights andobligationsof the student,the teacher, administrative and technical staff,

2. Integrity and responsible research

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

3. Ethics and professional conduct in the world of work:
Legal confidentiality in business. Loyalty to the company. Responsibility within the company, Conflicts of interest. Integrity (corruption in the workplace, its forms, its consequences, methods of combating and sanctions against corruption)

B- Intellectual property

I- Fundamentals of intellectual property

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

II- Copyright

1. Copyright in the digital environment

Introduction. Copyrightdatabases, software copyright. Specific case of free software.

2. Copyright in the Internet and e-commerce

Domain name law. Intellectual property on the internet. E-commerce site law. Intellectual property and social networks.

3. Patent

Definition. Rightsin a patent. Usefulness of a patent. Therepatentability. Patent applicationin Algeria and around the world.

III- Protection and valorization of intellectual property

How to protect intellectual property. Violation of rights and legal tool. Vvaluation of intellectual property. Protection of intellectual propertyin Algeria.

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:

Review: 100%

Bibliographic references:

1. Charter of university ethics and professional conduct,https://www.mesrs.dz/documents/12221/26200/Charte+fran__ais+d__f.pdf/50d6de61-aabd-4829-84b3-8302b790bdce
2. Orders No. 933 of July 28, 2016 setting the rules relating to the prevention and fight against plagiarism
3. The ABCs of Copyright, United Nations Educational, Scientific and Cultural Organization (UNESCO)
4. E. Prairat, On teaching ethics. Paris, PUF, 2009.
5. Racine L., Legault GA, Bégin, L., Ethics and engineering, Montreal, McGraw Hill, 1991.
6. Siroux, D., Deontology: Dictionary of Ethics and Moral Philosophy, Paris, Quadrige, 2004, p. 474-477.
7. Medina Y., Ethics, what will change in the company, Editions d'Organisation, 2003.
8. Didier Ch., Thinking about the ethics of engineers, Presses Universitaires de France, 2008.
9. Gavarini L. and Ottavi D., Editorial. of professional ethics in training and research, Research and training, 52 | 2006, 5-11.
10. Caré C., Morality, ethics, deontology. Administration and education, 2nd quarter 2002, n°94.
11. Jacquet-Francillon, François. Concept: professional ethics. Letélémaque, May 2000, n° 17
12. Carr, D. Professionalism and Ethics in Teaching. New York, NY Routledge. 2000.
13. Galloux, JC, Industrial property law. Dalloz 2003.
14. Wagret F. and JM., Patent of invention, trademarks and industrial property. PUF 2001
15. Dekermadec, Y., Innovating through patents: a revolution with the internet. INSEP 1999
16. AEUTBM. The engineer at the heart of innovation. Belfort-Montbéliard University of Technology

17. Fanny Rincketléda Mansour, literacy in the digital age: copying and pasting among students, University of Grenoble 3 and University of Paris-Ouest Nanterre la Défense Nanterre, France
18. Didier DUGUEST IEMN, Cite your sources, IAE Nantes 2008
19. Similarity detection software: a solution to electronic plagiarism? Report of the Working Group on Electronic Plagiarism presented to the CREPUQ Subcommittee on Pedagogy and ICT
20. EmanuelaChiriac, Monique Filiatrault and André Régimbald, Student guide: intellectual integrity plagiarism, cheating and fraud… avoiding them and, above all, how to properly cite your sources, 2014.
21. Publication of the University of Montreal, Plagiarism prevention strategies, Integrity, fraud and plagiarism, 2010.
22. Pierrick Malissard, Intellectual property: origin and evolution, 2010.
23. The website of the World Intellectual Property Organizationwww.wipo.int
24. http://www.app.asso.fr/

V - Detailed program by subject for the S3 semester

Semester: 3
Teaching unit: UEF 2.1.1
Matter:Materials
VHS: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
This subject aims to provide students withthe elements necessary to understand how a component or a structural part is made, with what materials and why, as well as the choice and control of the materials used. This objective aims to familiarize students with the different types of materials (metallic, polymers, ceramics, composites, etc.) and the associated concepts (elaboration, properties, shaping conditions, life cycles, limitations, etc.), problems of choice, availability...

Recommended prior knowledge:
Materials sciences and general and inorganic chemistry.

Content of the subject

Chapter 1: Reminder of perfect and imperfect (real) crystal structures

Chapter 2: Metallic materials
- **Phase transformations**: Definitions and fundamental concepts, solidification phenomena / Solidification of a pure metal by germination and growth / Solidification of alloys (dendritic growth / Binary alloy diagrams, liquid – solid and solid – liquid transformation, Applications to ferrous alloys and light alloys / Transformations in the solid state with and without diffusion / Adaptation of metallic materials to their use.
- **Thermal treatments**: quenching (TTT and TRC curves, critical quenching speed), tempering, aging, annealing (applications to steels and light alloys) / Thermochemical (case hardening, nitriding) and mechanical treatments (burnishing, shot peening). / Protection against corrosion, elementary corrosion mechanisms, coatings.

Chapter 3: Non-metallic materials
- **Polymeric (organic) materials**: Characteristics specific to plastic materials in relation to their structure – distinction between families of polymers (thermosetting, thermoplastics and elastomers), Mechanical behavior: (importance of the role of temperature and time) – shaping – degradation, aging, sensitivity to solvents
- **Ceramic materials**: Characteristics specific to ceramics in relation to their nature, Mechanical behavior – shaping.

Chapter 4: Materialscomposites
Association of materials-anisotropy-shaping process – assembly and machining problems, Specificities of mechanical behavior.

Chapter 5:Material selection criteria
- Creation of material specifications. / Functional analysis of a part (required qualities, characteristics and corresponding performance indices, required levels). /Establishment of specifications. / Mechanical characteristics. / Sources of data on materials (bibliography, database). / Selection criteria based on costs, availability, conditions of use

and manufacturing. / Selection of materials. / Raising awareness of the existence of tools to help with the selection of materials. / Case study.

Evaluation method:

Continuous assessment 40%, Final exam 60%.

Bibliographic references:

1. Treatise on materials, Introduction to materials science, JPMercier, G.Zambelli, W.Kurz, Presses polytechniques et universitaire romande.
2. Materials Science and Engineering, WDCallister,jr, MODULO.
3. Material Selection in NP Mechanical Design, by Michael F. Ashby, Collection:Technical and Engineering, Dunod/L'Usine Nouvelle, 2012,
4. Materials science and engineering, byWilliam-D and Jr Callister, Editions Modulo, 2001
5. Selection of materials and implementation processes, byMichael Ashby,Yves Bréchet,Luc Salvo, PPUR (Presses Polytechniques Universitaires Romandes), 2001.
6. Treatise on materials volume 20: selection of materials and implementation processes, by ASHBY Michael, Edition LAVOISIER, 2001.
7. Experimental characterization of materials I (TM volume 2): Physical, thermal and mechanical properties, bySuzanne DegallaixAndBernhard Ilschner, CollectionPPUR(Presses Polytechniques Universitaires Romandes), 2007.

Semester: 3
Teaching unit: UEF 2.1.1
Matter :Dynamics ofRotating machines
VHS: 45h (Class: 1h30, tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

- Focus on vibration modeling techniques for rotating machines.
- Master digital resolution methods and choose the appropriate modeling.
- Allow better control of the installation and use of rotating machines.
- Understand applications on industrial machines that are particularly sensitive to vibrational alterations of their components

Recommended prior knowledge

Mathematical calculation, finite element prerequisites, resistance of materials and structural dynamics.

Content of the material:

1- Introduction to rotor dynamics: History, rotor models, characteristics of rotor elements, Coordinate systems.
2- Simple rotor model: Campbell diagram, critical speeds, direct and inverse precessions, symmetrical and asymmetrical rotor, instability, damped rotors.
3- Finite element modeling of rotors.
4- Torsional vibrations of the rotors.
5- Influence of bearings on rotor vibrations.
6- Balancing the rotors.

Evaluation method:

Continuous monitoring :40%,Exam :60%.

Referencesbibliographic:*(Books and handouts, websites, etc.).*

1. Lee CW, Vibration Analysis of Rotors.Dordrecht, Kluwer AcademicPublishers, 1993.
2. G. Genta, Dynamics of Rotating Systems, Springer, New York, 2005.
3. Friswell MI, Penny JET,Garvey SD, Lees AW, Dynamics of Rotating Machines, Cambridge University Press, 2010.
4. Lalanne M., Ferraris G., Rotordynamics Prediction in Engineering, 2nd edition, Chichester, John Wiley, 1998.
5. Krämer E. Dynamics of Rotors and Foundations, Springer-Verlag, New York, 1993.
6. Childs D., TurbomachineryRotordynamics: Phenomena, Modeling, and Analysis, John Wiley & Sons, New York, NY, USA, 1993.

Semester: 3
Teaching unit: UEF 2.1.1
Matter :Framemetallic
VHS: 10:30 p.m. (Class: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:
Understand the basics of designing a metal frame.

Recommended prior knowledge:
RDM, Mechanical construction

Content of the material:

Chapter 1
General design criteria for a metal frame **(3 weeks)**

Chapter 2
Design and calculation of metal industrial halls **(4 weeks)**

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

Chapter 4
Base plates and anchoring of post bases **(3 weeks)**

Chapter 5
Constructive provisions and execution details **(2 weeks)**

Evaluation method:
Exam :100%.

Referencesbibliographic:

Picard, Beaulieu, Tromblay, Calculation of steel frames volume I PBTGM.

Semester: 3
Teaching unit: UEM 2.1.2
Matter :Composite materials
VHS: 45h (Class: 1h30, tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
Know new composite and heterogeneous materials and their applications.

Recommended prior knowledge:
Knowledge of materials sciences, MMC and development techniques.

Content of the material:

Chapter I General information on composite materials and their applications (02 weeks)

Chapter II Processes for obtaining constituents and manufacturing composites (02 weeks)

II. 1. Obtaining fibers (glass, carbons, aramids, boron, etc.)
II.2. Organic matrices and polymers.
II. 3. Manufacturing of composites.
- "Contact" molding.
- Projection molding.
- Fiamentary winding.
- Pultrusion.
- The compression.
- The injection.
- Pre-impregnated draping.

Chapter III Mechanical properties of composites (03 weeks)

-Micromechanical homogenization - Law of mixtures -Determination of the elastic properties of an orthotropic fold.
- Longitudinal modulus of elasticity.
- Transverse modulus of elasticity.
- Shear modulus.
- Poisson coefficient.

Chapter IV elastic behavior of a unidirectional composite (04 weeks)

Law of behavior in the plane of a unidirectional fold.
- Flexible behavior.
- Behavior in rigidity.
- Law of behavior outside the orthotropy axes.
- Behavior law of a multilayer laminate.

Chapter V thermomechanical behavior of a unidirectional composite (01 weeks)

Chapter VI bending behavior of composite laminates (03 weeks)

- Bending of thin plates (Kirchoff hypothesis).
- Bending of thick plates with transverse shear (Mindlin hypothesis).
- Bending of Sandwich plates.

Chapter VII Breakages and damage to composites (02 weeks)

- Damage to composites and means of control.
- Composite failure criteriaunidirectional UD(classic and interactive criteria:rupture criterion of Hill, Tsai-Hill, Tsai-Wu, Hoffman, Fisher, Norris, Ashkenazi,…).

Evaluation method:
Continuous monitoring :40%,Exam :60%.

Referencesbibliographic:

1. Composite materials, Mechanical behavior and analysis of structures, Jean-Marie BerthelotHermès - Lavoisier.
2. Materials and surfaces in tribology, by Jamal Takadoum, editionhermes 2001.
3. Composite materials, Author Claude Bathias, dunod 2005.
4. Composite materials with organic matrices v15 - Constituents, Processes, Properties. Treatise on Materials, Author(s): J. Manson, P.-E. Bourban, L. Carlsson,J.-p. Mercier, Editor:French-speaking polytechnic and university presses.

Semester:3
Teaching unit: UEF 2.1.2
Matter :Fracture mechanics and fatigue
VHS: 45h (Class: 1h30, tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The primary objective of the course is to introduce learners to the calculation of structures subjected to cyclic loading. The knowledge provided by the course allows, when designing structures, to take into consideration the fatigue life and toughness of materials. The course is divided into two parts. The first consists of an initiation of fatigue which constitutes one of the main causes of rupture. Particular attention is paid to fatigue at large number of cycles. The second part of the course focuses on the mechanics of fracture which highlights the interaction between a geometric discontinuity (crack) and the surrounding continuous medium. We are particularly interested in the stress field in the vicinity of a crack as well as in the shape of the plastic zone which develops at the crack tip. Under cyclic stresses, the initiation and propagation of cracks are also studied.

Recommended prior knowledge:

Elasticity, Mechanics of continuous media, Materials, Differential and integral calculus, Complex numbers and trigonometry.

Material content:

Chapter I: Mechanical characterization of materials (1 week)

Chapter II: Material fatigue (5 weeks)

II-1 Concepts on cyclic loading.
II-2 Nature and characteristic of the cyclic loading signal.
II-3 Endurance curve and its three domains: oligocyclic -Limited and unlimited endurance.
II-4 Mathematical expressions of the endurance curve.
II-5 Parameters of influence on fatigue.
II-6 Behavior law in the field of low-cycle fatigue.
II-7 Fatigue with a large number of cycles - Multiaxial fatigue criteria: empirical, global and with a critical plane approach.

Chapter III: Linear fracture mechanics (4 weeks)

III-1 Fundamental concepts of fracture mechanics.
III-2 The three modes of cracking.
III-3 Methods for analyzing stress fields in the vicinity of a crack.
III-3-1 Direct approaches: resolution of Wastergaad, resolution by Williams expansion, resolution by Mushkilishvili analysis.
III-3-2 Energy approach.
III-4 Toughness of materials.

Chapter IV: Behavior of the material in the vicinity of a crack (3 weeks)

IV-1 Introduction.
IV-2 Irwin's approach.
IV-3 Dugdale-Barenblatt model.
IV-4 Shapes of the plastic zone at the crack tip.

Chapter V: Initiation and propagation of fatigue cracks (2 weeks)

V-1 Initiation and study of the different stages of crack propagation.

V-1 Laws of crack propagation: Paris law.

Evaluation method:

Continuous monitoring: 40%; Exam: 60%

Bibliographic references:

1- *RECHO Naman, Mechanics of fracture by cracking - Theoretical, conceptual and numerical aspects, Publisher: Lavoisier, 2012.*

2- *Alain Cardou, Plasticity, fatigue and fracture of metallic materials: mechanical models, Editor:Loze-Dion editor, 2006.*

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

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

5- C. Bathias, JP Baillon,*Material fatigue and structure*, Hermesedition, 1997.

6- D. François, A. Pineau, A. Zaoui,*Mechanical behavior of materials*, Hermes 1992.

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

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

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

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

Semester: 3
Teaching unit: UEM 2.1
Matter :Office methods
VHS: 45h00 (Class: 1h30, TP: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The methods office constitutesthe interface between manufacturing or production workshops and design offices. Indeed,the roles and missions of amethods office particularly admit the verification, with the design office, of the feasibility and manufacturability of a product. The main objective of the teaching provided is to introduce students to developing a manufacturing process by taking into consideration the product definition drawing, the type of production as well as the means and tools essential for production.The aim lies in the acquisition, by the learner, of the knowledge required for the establishment of a complete manufacturing process for a product, particularly the design of machining range projects and the development of phase contracts. . It is fundamental that these projects integrate, in line with production costs, the scheduling of the different machining operations and their grouping into sub-phases and phases, the judicious choice of machine tools and tools and the calculation of processing times. 'machining.

Recommended prior knowledge:

Industrial design, Basic technology, Mechanical manufacturing, Materials sciences, TP Mechanical manufacturing,Conventional and Advanced Manufacturing Techniques.

Content of the material:

I-Introduction **(2 weeks)**
- I-1 The production function.
  - I.1.1. Organization of the production function
  - I.1.1.1. Operational role
  - I.1.1.2. Functional role
- I-2 Role and mission of a methods office.
  - I.2.1. Function methods and company size
  - I.2.2. Key missions of a method office
- I-3 Analysis of the definition drawing.
- I-4 Concepts of shape and position tolerances.
  - I.4.1. Indication of a reference element
  - I.4.2. Entering the tolerance value
  - I.4.3. Registration of references
  - I.4.4. Form tolerances
  - I.4.5. Orientation tolerances
  - I.4.6. Position tolerances
  - I.4.7. Runout tolerances

II- Isostatism **(3 weeks)**
- II.1. Definition of isostatism
  - II.1.1. Isostatism rules
- II-2 Part picking.
  - II.2.1. Rules for choosing positioning
- II-3 Technological and geometric symbolization.

II.3.1. Technological symbolization
II.3.2. Type of technology
II.3.3. Nature of the surface identified
II.3.4. Function of the technological element
II.3.5. Nature of the contact surface
II.3.6. Concept of normal
II.3.7. Standardized Representation
II.3.8. Elementary connections

II-4 Choice of positioning surfaces.
II.4.1. Fundamental principle
II.4.2. Choice rules
II.4.2.1. Rule 1
II.4.2.1. Rule 2
II.4.2.1. Rule 3

II-5 Application examples.

III- Manufacturing quotation **(3 weeks)**

III-1 Manufacturing dimension: tool dimension, machine dimension and equipment dimension
III.1.1. Definition of a manufactured dimension
III.1.2. Finding a logical machining dimension
III.1.3. Basic rules to follow
III.1.4. Different manufacturing dimensions
III.1.4.1. Machine dimensions (Cm)
III.1.4.2. Device ratings (Ca)
III.1.4.3. Tool dimensions (Co)
III.1.4.4. Concept of auxiliary adjustment frame of reference
III.1.4.5. Advice

III-2 Rating transfer
III.2.1. Definitions
III.2.1.1. Direct rating
III.2.1.2. Rating transferred
III.2.1.3. Ratings-methods
III.2.1.4. CC Condition Ratings
III.2.1.5. Economic tolerances
III.2.2. Example of transfer of dimensions
III.2.3. Conventions adopted to draw the transfer graph
III.2.4. Methods for calculating a rating transfer
III.2.4.1. Limit odds method
III.2.4.2. Average odds method
III.2.4.3. Calculation of total transfer

III.3. Transfer of orientation tolerances
III.3.1. Direct realization
III.3.2. Transferring a parallelism tolerance
III.3.3. Transferring a perpendicularity tolerance

IV- Elementary operations and prior artdue to machining constraints**(2 weeks)**

IV -1 Basic machining operations: turning, milling, drilling, reaming, gear cutting and grinding.
IV.1.1 Turning operations
IV.1.2 Milling operations

IV.1.3 Drilling operations
IV.1.4 Boring operation
IV.1.5 Gear cutting operations
IV.1.6 Rectification operations

IV -2 Prioritiesdue to machining constraints: dimensional, geometric and technological.
IV.2.1 Dimensional specification (quotation) constraints
IV.2.1.1 The connection between a raw surface and a machined surface
IV.2.1.2 The connection between machined surfaces
IV.2.1.3 Associated machined surfaces
IV.2.2 Geometric (order) specification constraints
IV.2.2.1 Form tolerances
IV.2.2.2 Orientation tolerances
IV.2.2.3 Position tolerances
IV.2.2.4 Example order of operations
IV.2.3 Examples of orders of operations in the phase imposed by the specifications
IV.2.4 Technological (sequence) constraints
IV.2.4.1 Elementary operations
IV.2.4.2 Keyway
IV.2.4.2 Intersecting bores
IV.2.4.3 Counterbore and tapped hole
IV.2.4.4 Clearance grooves

V- Establishment of a complete product manufacturing process and design of machining ranges **(5 weeks)**
V.1 Introduction
V.2 Drawing and production of the raw part
V.2.1 Assumptions relating to the part
V.2.2 Manufacturing assumptions
V.2.3 Assumptions relating to workshop equipment

V-3 Determination of the number of machining operations according to the quality and condition of the machined surface.
V-4 Determination of the history of machining operations.
V-5 Matrix method for establishing the machining order.
V-6 Grouping of machining operations in phase and sub-phase.
V-7 Machining range project.
V-8 Contract for the different machining phases and choice of cutting regime.
V-9 Examples of machining range for gear wheel .

<u>Guided Work Program (or Practical Work)</u> (1h30/week)

- TD (TP) n°1: Analysis of a definition drawing of a given part.
- TD (TP) n°2: Analysis of positioning a part with the use of geometric and technological symbolizations.
- TD (TP) n°3: Analysis of a manufacturing quotation (dimensional).
- TD (TP) n°4: Analysis of a manufacturing dimension (geometric).
- TD (TP) n°5: Carrying out a dimension transfer from a definition drawing for a given machining operation.
- TD (TP) n°6: Study of elementary turning operations with determination of the cutting speed.

- TD (TP) n°7: Study of elementary milling operations with determination of the cutting speed
- TD (TP) n°8: Study of elementary drilling/reaming operations with determination of the cutting speed
- TD (TP) n°9: Study of machining prior art for a given part.
- TD (TP) n°10: Analysis and determination of the number of machining operations, for a given part, according to the quality and surface condition.
- TD (TP) n°11: Matrix method for establishing the machining order for a part of revolution.
- TD (TP) n°12: Matrix method for establishing the machining order for a part of any shape.
- TD (TP) n°13: Project for a machining range for a revolution part.
- TD (TP) n°14: Project for a machining range for a part of any shape.
- TD (TP) n°15: Analysis of phase contracts for a revolutionary part.

Evaluation method:

Continuous assessment: 40%, Examination: 60%.

Bibliographic references:

1. AnselmettiB., '*Tolerancing Manual(Volume 4): Manufacturing quotation with ISO standards'*,Hermes Science Publications, 2010.
2. GaraS., '*Production - Machining processes:Turning, milling, drilling, grinding'*,EditionsEllipses Marketing, 2014
3. Pimbaud L., Layes G., Moulin J., 'Practical guide to machining (volume 1)', Edition Hachette, 2003.
4. Barlier C., Poulet B., 'Mechanical production', Mémotech Collection, Editions Casteilla, 1999
5. Chevalier A, Bohan J., Molina A., 'Practical guide to manufacturing', Editions Hachette, 2000.
6. Padilla P. and Thely A., 'Guide to Mechanical Manufacturing', Dunod, 1978.
7. Padilla P.,AnselmettiB., Mathieu L. and Raboyeau M., 'ProductionMécanique', Editions Dunod, 1986.
8. Weill R., 'Design of machining ranges', Engineering Techniques Doc B2 025, 1993
9. Matthieu L. and 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.
10. Hassin S., 'Multi-criteria qualification of machining ranges: application to aeronautical structural parts in Airware alloy', Doctoral thesis, Blaise Pascal University - Clermont-Ferrand II, 2015.
11. André Chevalier, “Industrial designer’s guide”, Hachette technique, 2004.
12. Saber A, “Manufacturing analysis the preparer the methods office”, Algiers: Technology, p. 328.
13. JP Trotignon et al., “Mechanical construction specifications”, Volume 2, Project-Methods, Production, Standardization”, Nathan, 2006.
14. Georges Paquet, “Guide to machining”, Delagrave, 2000.
15. R Quatremer et al., “Precis of mechanical construction”, Volume 1, Projects-Studies, Components, Standardization, Pierre de Coubertin, Paris: Nathan, 2006.
16. Bruce Anglade – Hélène Horsin Molinaro, “Gear cutting by generation, hob tool”, Course handout, Ecole Normale Supérieure Paris-Saclay, 2017.
17. Bruce Anglade – Hélène Horsin Molinaro, “Gear cutting without generation”, Course handout, Ecole Normale Supérieure Paris-Saclay, 2017.

18. JP Trotignon et al., “Mechanical construction details”, Vol. 2, Pierre de Coubertin, Paris: Nathan, 2002.
19. Philippe DEPEYRE, “Mechanical manufacturing”, Course handout, University of Reunion, 2004-2005.
20. EugideLalé MBUNDA, “Test of modeling the production function in an industrial company. Case of the Butuhe tea complex “CTB SPRL” from 2003 to 2008”, University of CEPROMAD, 2008.
21. Xavier BLOUËT, “The Industrial Methods function: Pivotal to industrial competitiveness”, Elite Organization, 12/17/2015. [Consulted 01/18/2020]. Available at: http://www.elite-organization.fr/a-propos/references/parole-d-expert/291-la-entreprises-methodes-industrielles-pivot-de-la-competitivite-industrielle.html.
22. Cristian Hohmann, “Lean transformation model”, Since 1988. [Consulted on 01/18/2020]. Available on :http://christian.hohmann.free.fr/index.php/lean-entreprise/lean-management/346-lean-transformation-model.
23. Vieille B, “Methods and manufacturing”, Conservatoire National des Arts et Métiers – automated production, 2017.
24. Philippe Berger, “Isostatism-Symbolization of technological elements”, 2017. [Consulted on 01/18/2020]. Available at: http://philippe.berger2.free.fr/ productique/ resources/isostatisme/isostatisme.htm
25. “Mechanical manufacturing-free course in mechanical engineering, isostatism and technological symbolization”, 2013. [Consulted on 01/18/2020]. Available on:https://fabrication1.blogspot.com/2013/09/lisostatisme.html
26. JF Debongnie, “Complement to mechanical manufacturing and CAM (MECA2453)”, Course handout, University of Liège, 2010. Available on:http://hdl.handle.net/2268/26025.
27. Ion-Cosmin GRUESCU, “The transfer of odds (TC)”, 2015. [Consulted on 01/18/2020]. Available at: http://analyse-fabrication.univ-lille1.fr/co/ch4_1_2.html.

Semester: 3
Teaching unit: UEM 2.1
Matter :Turbomachines
VHS: 37h30 (Class: 1h30, practical work: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives:
The course essentially aims to familiarize the student with the operation and energy calculation of a turbomachine. To this end, the notions of thermodynamics are applied to turbomachines to calculate the different yields and performances.

Recommended prior knowledge:
Basic notions of thermodynamics and fluid mechanics are required.

Content of the material:

I. General definitions of turbomachines (01 week)
II. Similarities in turbomachines (02 weeks)
III. The pumps (03 weeks)
Centrifugal pumps
Axial pumps
Velocity triangles
Powers and yields
IV. Cavitation in pumps (02 weeks)
V. Centrifugal pump couplings (01 week)
VI. Sizing of centrifugal pumps (02 weeks)
VII. Hydraulic turbines (03 weeks)
Pelton turbine, Francis turbine, Kaplan turbine

Evaluation method:
ControlContinuous :40%,Exam :60%.

Referencesbibliographic:

1. Dixon (1998), Fluid mechanics and thermodynamics of turbomachinery, 4thed Butterworth-Heinemann
2. Albin BOLCS (1990), Thermal turbomachines, EPFL Lausanne, VOL 1 & 2.
3. *R. Comolet, Experimental fluid mechanics, Volume II, dynamics of real fluids, turbomachines, Editions Masson, 1982.*
4. *B. Lakshminarayana, Fluid Dynamics and Heat Transfer of Turbomachinery, Wiley, New York, 1996.*

Semester: 3
Teaching unit: UEM 2.1
Matter :Digital simulation software in mechanics
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:
Have an idea about numerical simulation software in mechanics and teach students the practical resolution of some problems.

Recommended prior knowledge:
Notions of general mechanics and computer science

Content of the material:
Choice of software (or more) for numerical simulation in mechanics and give some examples of problems:

- **TP No. 1:**1D linear statics problem (Bar, beam). **(1 week)**
- **TP No. 2:**2D linear statics problem (Plane stresses, plane strains). **(1 week)**
- **TP No. 3:**3D linear statics problem (Tetrahedral elements, cubic elements). (1 week)
- **TP No. 4:**Geometric nonlinearity (Large deformation, buckling). (2 weeks)
- **TP No. 5:**Nonlinearity of the material (plastic deformation, creep, viscoelasticity). **(2 weeks)**
- **TP No. 6:**Contact problem. **(1 week)**
- **TP No. 7:**Thermomechanical problem. **(1 week)**
- **TP No. 8:**Anisotropic material (Composite materials). **(2 weeks)**
- **TP No. 9:**Calculation of the natural frequencies of a structure. **(1 week)**
- **TP No. 10:**Harmonic analysis of a structure. **(1 week)**
- **TP No. 11:**Rigid dynamic analysis. **(1 week)**
- **TP No. 12:**Heat transfer in transient conditions. **(1 week)**

Evaluation method:
ControlContinuous: 100%.

Bibliographic references:

Semester: 3
Teaching unit: UET 1.3
Subject 1:Documentary research and dissertation design
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Give the student the necessary tools to search for useful information to better use it in their end-of-studies project.Help them go through the different stages leading to the writing of a scientific document. Tell himthe importance of communication and itlearn to present the work carried out in a rigorous and educational manner.

Recommended prior knowledge:
Writing methodology, Presentation methodology.

Content of the subject:

Part I-: Documentary research:

Chapter I-1: Definition of the subject (2 weeks)
- Subject title
- List of keywords relating to the subject
- Gather basic information (acquisition of specialized vocabulary,meaning of terms, linguistic definition)
- The information sought
- Take stock of your knowledge in the field

Chapter I-2:Select information sources (2 weeks)
- Type of documents (Ldrunk, Theses, Memoirs, Periodical articles, Conference proceedings, Audiovisual documents, etc.)
- Type of resources (Libraries, Internet, etc.)
- Evaluate the quality and relevance of information sources

Chapter I-3:Locate documents (1 week)
- Research techniques
- Search operators

Chapter I-4: To process information (2 weeks)
- Work organization
- Starting questions
- Summary of documents retained
- Links between different parties
- Final plan of the documentary research

Chapter I-5: Presentation of the bibliography (1 week)
- Systems for presenting a bibliography (The Harvard system, The Vancouver system, The mixed system, etc.)
- Presentation of documents.
- Citation of sources

Part II: Design of the dissertation

Chapter II-1: Plan and stages of the dissertation (2 weeks)
- Identify and delimit the subject (Summary)

- Problem and objectives of the dissertation
- Other useful sections (Acknowledgments, Table of abbreviations, etc.)
- The introduction (The writing of*the introduction last)*
- State of the specialized literature
- Formulation of hypotheses
- Methodology
- Results
- Discussion
- Recommendations
- conclusion and perspectives
- Table of contents
- The bibliography
- Annexes

Chapter II-2: Writing techniques and standards (2 weeks)

- Formatting.Numbering of chapters, figures and tables.
- Cover Page
- Typography and punctuation
- Writing. Scientific language: style, grammar, syntax.
- Spelling.Improved general language skills in terms of comprehension and expression.
- Back up, secure, archive your data.

Chapter II-3:Workshop : Critical study of a manuscript **(1 week)**

Chapter II-4: Oral presentations and defenses (1 week)

- How to present a Poster
- How to present an oral communication.
- Defense of a dissertation

Chapter II-5: How to avoid plagiarism? **(1 week)**

(Formulas, sentences, illustrations, graphs, data, statistics,...)

- The quote
- The paraphrase
- Indicate the complete bibliographic reference

Evaluation method:

Review: 100%

Bibliographic references:

1. *M. Griselin et al., Guide to written communication, 2nd edition, Dunod, 1999.*
2. *JL Lebrun, Practical guide to scientific writing: how to write for the international scientific reader, Les Ulis, EDP Sciences, 2007.*
3. *HAS.Mallender Tanner, ABC of technical writing: instructions for use, user manuals, online help, Dunod, 2002.*
4. *M. Greuter, Write your dissertation or internship report well, L'Etudiant, 2007.*
5. *Mr. Boeglin, reading and writing in college. From the chaos of ideas to structured text. The Student, 2005.*
6. *M. Beaud, the art of the thesis, Editions Casbah, 1999.*
7. *M. Beaud, the art of the thesis, The discovery, 2003.*
8. *M. Kalika, Master's thesis, Dunod, 2005.*

Proposal of some discovery materials

Semester:
Teaching unit: UED XX
Matter:Tribology
VHS: 10:30 p.m. (Class 1h30)
Credits: 1
Coefficient: 1

Recommended prior knowledge:
Rational Mechanics, Strength of Materials, Basic Technology, Materials Science and Elasticity.

Teaching objectives:
The objective of the subject is to introduce students to tribology and in particular to the description and interpretation of phenomena likely to occur between two material systems in contact, immobile or animated by relative movements. It covers, among other things, all areas offriction, of the'wear, the elastic contact between two solid bodies and thelubrication.

Content of the material:
I- Introduction to tribology **(2 weeks)**

- Definition of tribology
- Tribological system
- Knowledge of a surface
- The concept of the third body
- Surface degradation mechanisms

II- Study of friction **(4 weeks)**

- Origin of friction force
- The different types of friction (sliding, rolling and pivoting)
- Adhesion and friction phenomena - Static and kinetic friction coefficient
- The different friction models:Coulombian and non-Coulombian

III- Forms of wear **(3 weeks)**

- Definition
- Empirical classification of wear
- Technological classification of wear
- Scientific classification of wear
- Main modes of wear
- Study and quantification of wear

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

- Geometry of contact surfaces
- Relative movement of surfaces
- Forces transmitted to the point of contact
- Contact mechanics
- Hertz's theory of normal contact
- Case of sphere-sphere and sphere-plane contact
- Case of cylinder-cylinder and cylinder-plane contact

V- Introduction to hydrodynamic and hydrostatic lubrication**(2 weeks)**

Evaluation method:

Review: 100%.

Bibliographic references:

1. Stolarski T., Tribology in Machine Design, Butterworth-Heinemann Publisher, 1999.
2. Frêne J., Nicolas D., Degueurce B., Berthe D. and Godet M., Hydrodynamic lubrication: bearings and thrust bearings,Let's edit Eyrolles, 1990.
3. Georges JM, Friction, wear and lubrication, CNRS Editions,Let's editEyrolles, 2000.
4. Johnson KL, Contact Mechanics, Cambridge University Press, 1985.
5. Williams JA, Engineering Tribology, Ed. by Oxford University Press Inc., 1994.
6. KapsaP., Tribology: Fundamentals and Complex Applications, Presse de l'école des mines, 2014.
7. TakadoumJ., Materials and surfaces in tribology, Editor:Hermès / Lavoisier, 2007.
8. HutchingsIM, Tribology: Friction and Wear of Engineering Materials,Publisher: CRC Press, 1992.
9. StachowiakG.,BatchelorAW, Engineering Tribology, Fourth Edition, Publisher: Butterworth-Heinemann, 2013.

Semester:x
Teaching unit: UED xx
Matter :Non-destructive testing (NDT)
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The objective is to have the student learn a set of methods making it possible to characterize the state of integrity of structures or materials, without degrading them, either during production, during use, or in the maintenance framework. We speak of non-destructive testing (END) or non-destructive examinations1.

Recommended prior knowledge:

Processes for obtaining parts, welding

Content of the material:

Chapter 1: Introduction

1. Presentation: definition; NDT and maintenance; defects encountered (development defects; manufacturing or assembly defects; operating defects)
2. Common methods: visual inspection; dyeing; magnetic particle scanning; x-ray; eddy currents; ultrasound.
3. Areas of application: nuclear power plants**; steel cables; tanks.**

Chapter 2: Basic Principles

1. Visual examination
2. Generalization of the principle to different techniques.

Chapter 3: Sweating

1. Principles of the method
2. Physico-chemical properties involved: definition of parameters; physical laws brought into play; the bleeding mechanism.
3. Different types of products used: penetrants; emulsifiers; the revealers.
4. Operating technique adapted to different products.
5. Choice of products according to requirements.
6. Control measures. Room control documents
7. Standards. Advantages and disadvantages

Chapter 4 - magnetic particle scanning

1. General principle: introduction; principle.
2. Basic notions of magnetism and electromagnetism.
3. Principle of the method: excitation; the perturbation ; the revelation ; ...; detectable defects.
4. Implementation of the method: preparation of parts; choice of current form; ...
5. Interpretation of results: representative spectra; conservation of results; examples; ...
6. Advantages and disadvantages. Standards.

Chapter 5 - eddy currents

1. Introduction
2. Physical principles: electromagnetic induction; Faraday's law; inductance of a solenoid;

concept of impedance; series association of a resistance and an inductance; generation of currents.
3. Fault detection: simplified principle of instrumentation; principle of detection; …
4. Equipment.
5. The different examinations: external examinations of tubes; internal tube examinations; …
6. Advantages, disadvantages, limitations of the method: defects highlighted; controls of ferromagnetic materials; advantages and disadvantages ; other applications; standards.

Chapter 6 - ultrasonic checks
1. Introduction
2. Physical principles: matter; defects in solids; vibrations; sounds and ultrasound; …
3. The production of ultrasound: the piezoelectric phenomenon; acoustic intensity; ….
4. Ultrasonic testing techniques.
5. Performance: fault detection; fault location and characterization; ….
6. The equipment.
7. Advantages, disadvantages, limitations of the method: advantages and disadvantages; standardization.

Chapter 7- acoustic emission
1. Principle.
2. Advantages, disadvantages, limitations of the method: field of application; main application sectors; advantages and disadvantages.

Chapter 8- x-ray
1. Principle.
2. Physical principles: sources of radiation; electromagnetic spectrum of light; …
3. Performance, limits of the method

Evaluation method:
Review: 100%

Bibliographic references:

Semester: x
Teaching unit: UEDxx
Matter :Production management
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
The objective is to have the student learn all of the activities involved in the design, planning of resources (material, financial, or human), their scheduling, the recording and traceability of production activities, the control of the production activities of the enterprise.

Recommended prior knowledge:
Industrial maintenance

Content of the material:

Chapter 1: Evolution of production management
1. Pre-industrial production
2. Mechanical production
3. New forms of production management

Chapter 2: The systematic approach to production management
1. Overview of systems theory
2. Means and tools
3. The business system
4. The production system

Chapter 3: Tools for production management
1. The statistical tool
2. Linear programming
3. Computing

Chapter 4: Technical organization of production management
1. Business strategy and production planning
2. Production and study function
3. The product and value analysis
4. The methods function
5. Forecasting and inventory management
6. The scheduling function
7. The quality control function

Chapter 5: Support Logistics
1. The purchasing and supplies function
2. Outsourcing
3. Installations and handling
4. Industrial maintenance
5. Automation

Chapter 6: evaluation and control of the production system

1. Production diagnosis
2. Production audit

Evaluation method: Exam: 100%

Bibliographic references:

(1) : L. Boyer, M. Poirée E. Salin, Summary of the organization of production management, Les éditions d'organization, Paris (1986)

Semester: x
Teaching unit: UEDxx
Matter:Industrial Security
VHS: 10:30 p.m. (Class 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Know the different dangers and their sources in order to establish rules of conduct. Minimize risks during design by introducing constraints that take into account the different dangers.

Recommended prior knowledge:
Chemistry, physics, vibrations, applied electricity.

Content of the material:

Chapter 1. General: (2 weeks)
(Introduction, analysis of work accidents and occupational diseases, process of occurrence of damage, main risk factors, statistics, safety signs, general safety instructions at the workplace).

Chapter 2. Lighting: (2 weeks)
(Introduction, photometric quantities, characteristics, recommended lighting levels, carrying out a lighting project).

Chapter 3. Noise: (2 weeks)
(Generation of sound waves, sound intensity, sound power, addition of noise levels, ear sensitivity, admissible limits, protective measures).

Chapter 4. Vibrations: (2 weeks)
(Reminders on vibrations, vibrations of the hand-arm assembly, vibrations of the whole body, calculation of doses, acceptable limits, protective measures).

Chapter 5. Electrical risk: (2 weeks)
(Physiological effects of electric current, factors influencing bodily damage, classes of equipment, protection against overcurrents and overvoltages, rescue in the event of an accident).

Chapter 6. Chemical risk: (3 weeks)
(Substances, preparations, risk of poisoning, routes of entry, degree of toxicity, limit concentrations, pictograms, risk phrases, toxicological data sheets, fire-explosion risk, protective measures).

Chapter 7. Ionizing radiation: (2 weeks)
(Reminders on the structure of matter (atoms, molecules, isotopes), radioactivity and units of measurement, law of radioactive decay, ionizing radiation (α, β,γ, X, neutrons), natural and artificial radioactivity, effects of ionizing radiation, dose limits).

Evaluation method:
Exam: 100%

Bibliographic references:

1. *N. MARGOSSIAN, "Occupational risks", Ed. Dunod, 2006.*
2. *N. MARGOSSIAN, "Practical guide to professional risks", Ed. Dunod, 2003.*
3. *J. RIDLEY and J. CHANNING, "Safety at Work", Ed. Butterworth-Heinemann, 2003.*
4. *CD REESE, JV EIDSON, "Handbook of OSHA Construction, Safety and Health", Ed. CRC Press, 2006.*
5. *D. MACDONALD, "Practical Machinery Safety", Ed. Elsevier, 2004.*
6. *T. KLETZ, "Learning from Accidents", Ed. Butterworth-Heinemann, 2001.*
7. *LR COLLINS, TD SCHNEID, "Physical Hazards of the Workplace", Ed. CRC Press, 2001.*
8. *S. LAGRA, "Technical prevention of occupational risks", Ed. OPU, 1990.*
9. *P. VANDEPLANGUE, "Lighting", Ed. Techniques et Documentations Lavoisier, 1993.*
10. *M. LATOISON, "Introduction to lighting engineering", Ed. Eyrolles, 1982.*
11. *H. NEY, "3. Electrical installations", Ed. Nathan, 1986.*
12. *J. TOURRET, "Industrial noises", Ed. Cetim, 1978.*
13. *T. SOUTH, "Managing Noise and Vibration at Work", Ed. Elsevier, 2004.*
14. *C. AZAIS, JP GUILHOT, P. JOSSERAND, M. WILD, "Industrial acoustics", Engineering techniques, R3120.*

Semester: x
Teaching unit: UED xx
Matter:Hydraulic and Pneumatic Systems
VHS: 10:30 p.m. (Class 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The objective of the program is to have students learn a body of knowledge essential and necessary for the physical understanding of hydraulic and pneumatic systems. This begins with the description of the different organs (cylinders, distributors, valves, etc.), until the establishment of the hydraulic or pneumatic diagrams

Recommended prior knowledge:

Knowledge of fluid mechanics, machine components and the laws of physics.

Content of the material:

Chapter 1 : Introduction and reminders **(2 weeks)**

- Hydraulic fluids: Mineral oils, synthetic oils and their characteristics.
- Calculation of load losses.
- Air and oil filtration.
- Air and oil filters: Types and choices.

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

- Pumps: Types, construction and choice of axial piston pumps, radial piston pumps, vane pumps, gear pumps, screw pumps.
- Pump calculation elements.
- Compressors: Types, construction and choice of compressors.
- Compressor calculation elements.
- Hydraulic motors: Axial piston motors, radial piston motors, gear motors, vane motors, slow cam and roller motors.
- Calculation elements for hydraulic motors.
- Single acting cylinders, double acting cylinder, double acting double rod cylinder, telescopic cylinder, rotary cylinder.
- Calculation of the cylinders.

Chapter 3: Other organs used in
Hydraulic and pneumatic circuits **(3 weeks)**

- Distributors: Types, construction, selection and ordering. (direct, indirect).
- Pressure relief valves: Types, construction, selection and ordering. (direct, indirect).
- Flow limiters: Types, construction, choice and order. (direct, indirect).
- Accumulators and tanks: Types, calculation and choice.
- Pipes: Materials, dimensions.
- Sensors: force, speed, position, temperature, etc.

Chapter 4: Practical Examples: **(4 weeks)**

- Establishment of hydraulic and pneumatic diagrams.
- Calculation of hydraulic and pneumatic circuits.

Evaluation method:
Review: 100%

Bibliographic references:

1. *Jacques Faisandier, Hydraulic and pneumatic mechanisms, Collection:Technical and Engineering, Dunod/L'Usine Nouvelle, 2013.*
2. *José RoldanViloria, Cheat Sheet: Industrial Hydraulics, L'Usine Nouvelle - Dunod.*
3. *R.-C. Weber, Safety of pneumatic systems, Festo Edition, 2012.*
4. *Simon Moreno,Edmond Peulot, Pneumatics in automated production systems, Editor(s):Casteilla, 2001.*

Semester: x
Teaching unit: UED xx
Matter:Inspection and control
VHS: 10:30 p.m. (Class 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

At the end of this course the student should be able tocheck the finished product against the specifications; he checks and certifies the conformity of the manufactured (and/or assembled) parts with the technical documentation.

Recommended prior knowledge:

- Knowledge of materials and techniques (machining, manufacturing, assembly).
- Knowledge of manufacturing processes and control points.
- Knowledge of standards and quality control techniques: metrology, testing.
- Application of strict processes.
- Statistical analysis.

Content of the material:

Chapter 1 : Scanning **(5 weeks)**

- Automatic 3D scanning
- Choice of systems
- Classification of systems
- Travel systems
- Acquisition systems for 3D inspection
- Different types of inspection
- Automatic acquisition
    - CAIP (Computer-Aided Inspection Planning)
    - CAPP (Computer-Aided Process Planning)

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

- Description of a three-dimensional measuring machine
- Principle of the coordinate measuring machine
- Structures of coordinate measuring machines
- Constitution of measuring machines
- The movement structure
- The probing system
- The electronic system
- The computer system and the control console
- The different architectures
- Different types of orders
    - Manual Machines
    - Motorized Machines
    - Numerical Control Machines
- Fixing Systems
- Measuring head technology
- The feelers
    - Ball contact probe
    - Dynamic probe

  - Static probe
  - Contactless probe
- CCD camera
- Laser Sensor

Chapter 3: CMM related software **(5 weeks)**

Evaluation method:
Review: 100%

Bibliographic references:

1. *Three-dimensional metrology "three-dimensional measuring machine course". UNIVERSITY INSTITUTE OF TECHNOLOGY OF MULHOUSE. 04/26/2005.*
2. *SPRUYT.G. Three-dimensional metrology "Technology of three-dimensional measuring machines". ISIPS*
3. *SPRUYT.G. Three-dimensional metrology "Measuring Machine Technology.*
4. *Alain April, Claude Laporte: Software Quality Assurance 1 - basic concepts, Hermes-Lavoisier; 2011,ISBN 9782746231474.*
5. *GROUS Ammar, Applied quality control - Case studies and new work organization, Hermes – Lavoisier, 2013.*
6. *Pierre CUÉNIN, Control. Quality, Engineering Techniques, Reference M3530 v1, 1997.*

Semester:
Teaching unit: UED XX.
Matter:Motion transformation mechanisms and cams
VHS: 10:30 p.m. (Class 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

This course complements the two subjects 'Mechanical Construction' and 'Theory of Mechanisms' taught in the third year 'Mechanical Construction' degree. This course focuses on motion transformation mechanisms, in general, and cam mechanisms, in particular, in addition to indexers and slide mechanisms. Considering their importance and their role in several industrial machines, special attention is given to cam mechanisms. The objective of the course isdeepening knowledge in the fieldelements of machines, as well as an introduction to kinematic and dynamic calculations, allowing learners to acquire a basis for the mastery, design and synthesis of these mechanisms.

Recommended prior knowledge:

Industrial design, Rational mechanics, Theory of mechanisms, Mechanical construction and Resistance of materials.

Content of the material:

Chapter 1 :Reminders on the theory of mechanisms (3 weeks)

- The different types of mechanical connections between solids.
- Cinematic chains.
- Static analysis of mechanisms
- Kinematic analysis of mechanisms

Chapter2: Sliding Mechanism Technology (3 weeks)

- Main sliding mechanisms
- Definitions of the elements of a slide mechanism

Chapter3: Kinematic analysis and synthesis of cam mechanisms (6 weeks)

- Cam classification
- Follower classification
- The different laws of movement of the follower
- Kinematic analysis of a cam mechanism
- Determining the minimum radius of a cam
- Geometric characteristics of the cams
- Construction of cams and followers
- Determining the profile of a cam
- Analytical methods of analysis
- Cam manufacturing

Chapter 4: Indexers (3 weeks)

- Definitions of different types of indexers
- Cam indexers
- Maltese cross mechanisms

Evaluation method

Review: 100%

Bibliographic references

1. MARTIN J., Local contact movement transformation mechanisms – Cam mechanisms, Engineering Techniques, 2004.
2. Vinogradov O. Fundamentals of kinematics and dynamics of machines and mechanisms, CRS Press, 2000.
3. DAVID H. MYSZKA., Machines and Mechanisms-Applied Kinematic Analysis, Prentice Hall, 2012.
4. Engineering techniques, B 5 910 Mechanical construction, Esnaut Volume 1.

Semester:x
Teaching unit UED xx
Matter :Industrial Hygiene and Safety (HSI)
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

- This consists of advising and assisting the company's management with regard to risk assessment and the definition of the safety policy for people, industrial installations, storage of raw materials, intermediates and finished products.
- It also involves putting in place the means corresponding to the prevention measures that result from this policy.
- This consists of organizing awareness-raising and training actions for personnel in the field (HSI).
- This consists of establishing analyzes and diagnoses following accidents and incidents.

Recommended prior knowledge:

Basic knowledge of industrial hygiene and safety.

Content of the material:

Chapter 1 : Analysis of work function **(3 weeks)**
Industrial hygiene risk assessments and risk prioritization
Hygiene, health and safety regulations and compliance audits
Monitoring exposure to chemical, physical, and biological agents

Chapter 2 : Hazardous Materials Management and Remediation Support **(3 weeks)**
Programs to combat asbestos, lead and other harmful elements
Noise mapping, noise dosimetry and control alternatives
Exposure control alternatives and recommendations

Chapter 3: Workplace safety analysis and risk assessment **(3 weeks)**
Hazard management in a confined space
Indoor air quality and mold assessment
Evaluation and design of local exhaust ventilation

Chapter 4: Preparation of material safety data sheets **(3 weeks)**
Classification of chemicals, and advisory services
Information and popularization of hazard risks
Development and delivery of training programs

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

Evaluation method:

Review: 100%.

Bibliographic references:

1- *Isabelle Correard,Patrick Anaya, Safety, hygiene and occupational risks, Edition(s): Dunod, 2011.*
2- *Nathalie Diaz, The great guide for QHSE managers: Quality, Hygiene, Safety, Environment, Lexitis Editions, 2014.*

3- *Benoît Péribere, The guide to safety at work: Manager's tools, AFNOR Editions, 2013.*
4- *Michel Lesbats, Risk management summary - The essentials of the course, tool sheets and corrected exercises, Edition(s): Dunod, 2012.*
5- *Ryan Dupont,Louis Theodore,Joseph Reynolds, Industrial safety: From accident prevention to emergency organization, solved problems, case studies, Publisher: Polytechnica, 1999.*
6- *Georges-G Paraf,Vve C. Dunod, Hygiene and safety in industrial work, Hachette Livre, 2015.*
7- *Jean-Pierre Mouton, Corporate safety - 3rd edition: Raising staff awareness and implementing an action plan, Edition(s): Dunod, 2010.*

Semester:x
Teaching unit UED xx
Subject: Industrial maintenance
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Plan, estimate, direct or carry out the installation, start-up, troubleshooting, modification and repair of devices, tools and machines;

Design, implement and manage preventive maintenance methods and processes;

Organize and carry out the modification or improvement of machines and production systems.

Recommended prior knowledge:
Basic notions of industrial maintenance.

Content of the material:

Chapter 1:Generalities and Definitions on Industrial maintenance **(2 weeks)**
-Introduction -Importance of maintenance in the company -Objectives of maintenance in the company -Maintenance policies in the company.

Chapter 2 :Organization of maintenance: **(1 weeks)**
-Place of maintenance in the general structure -Internal organization of maintenance -Human resources -Material resources

Chapter 3:Maintenance methods and techniques **(2 weeks)**
-General – Maintenance methods (corrective; systematic preventive and conditional preventive) -Maintenance operations-Related maintenance activities

Chapter 4:Availability and FMD concepts **(4 weeks)**
-Reliability – maintainability -Availability -Notions of FMD -Costs and analysis of an FMD policy-Analysis of failure modes, their effects and their criticality (FMEA)

Chapter 5:Machine file and technical documentation **(1 weeks)**
- Purpose of the documentation - Machine file

Chapter 6:Maintenance costs **(3 weeks)**
-Cost composition -Cost analysis and ABC method -Optimal preventive maintenance-Example of MTBF calculation-Optimization of replacement by using the probability model -Choice between maintenance and replacement -Economic lifespan -Decommissioning of material.

Chapter 7: CMMS **(2 weeks)**
Evaluation method:
Review: 100%.

Bibliographic references:

1- *Jean-Claude Francastel, Maintenance engineering: From design to operation of an asset, Editor(s):Dunod,The New Factory, Collection :Technique and engineering - Industrial management, 2009.*
2- *François Castellazzi,Yves Gangloff,Denis Cogniel, Industrial maintenance: Maintenance of industrial equipment, Editions: Cateilla, 2006.*
3- *Pascal Denis,Pierre Boye,André Bianciotto, Guide to industrial maintenance, Editions: Delagrave, 2008.*
4- *Serge Tourneur, Corrective maintenance in electrical equipment and installations: Troubleshooting and measurement, Editions: Cateilla, 2007.*
5- *Jean-Marie Auberville, Industrial Maintenance From Basic Maintenance to Optimization of Safety, Editions: Ellipse.*
6- *Sylvie Gaudeau, Hassan Houraji, Jean-Claude Morin, Julien Rey, Maintenance of industrial equipment. Volume 1: From component to system. Editions: Hachette.*

Semester: x
Teaching unit: UEDxx
Subject: Energy Audit
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Present the tools for carrying out an energy audit and allow students to acquire the knowledge necessary to carry out energy audits in different sectors of activity.

Recommended prior knowledge:

Thermodynamics, thermal transfer, Thermal machines

Content of the material:

Chapter 1. General information on energy (2 weeks)
- Types and sources of energy
- Energy transport
- Algerian Energy Pricing System (electric and thermal)
- Algerian legislation and energy audit obligation

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

Chapter 3: Energy audit methodology (4 weeks)
- Preliminary audit
- Detailed audit
- Recommendation of energy saving solutions
- Costing of solutions and return time
- Writing the audit report

Chapter 4: Implementation of an energy management system (2 weeks)
- The ISO 50001 standard

Chapter 5: Case study (3 weeks)

Evaluation method:
Review: 100%.

Bibliographic references:

1. The energy audit, PA Bernard, 1995
2. Technical guide to energy audit, K. Moncef and M. Dominique, 2016
3. Material and energy balances, G. Henda, 2012
4. www.aprue.org.dz
5. *Aidan Duffy,Martin RogersandLacourAyompe,Renewable Energy and Energy Efficiency: Assessment of Projects and Policies, Wiley-Blackwell, 2015.*
6. *D. Yogi Goswami, Frank Kreith, Handbook of Energy Efficiency and Renewable Energy, CRC Press, 2007.*

7. *Official Journal of the Algerian Republic No. 84 29, Executive Decree No. 05-495 of 24 Dhou El Kaada 1426 corresponding to December 26, 2005 relating to the energy audit of establishments that consume large amounts of energy.*

Semester: x
Teaching unit: UEDxx
Material: Renewable energy
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Have general knowledge of renewable energies

Recommended prior knowledge:

Heat transfer, MDF, thermodynamics

Content of the material:

1. The Solar Field **(2 weeks)**
2. Thermal Conversion: Low Temperature Applications (**3 weeks)**
3. Photovoltaic Conversion **(2 weeks)**
4. Geothermal energy **(2 weeks)**
5. Wind energy **(2 weeks)**
6. Hydroelectric power **(1 week)**
7. Biomass energy **(1 week)**
8. Energymarine (or oceanic) **(1 week)**
9. Solar Energy Storage **(1 week)**

Evaluation method:
Review: 100%.

Bibliographic references:

1- *Ahmed F. Zobar, Ramesh Bansal, "Handbook of Renewable Energy Technology", World Science (2011)*
2- *Henrik Lund "Renewable Energy Systems" Academic Press (2010)*
3- *Solar energy. Calculation and optimization - Energy engineering,Jacques Bernard, Editing :Ellipses, 2004.*
4- *The solar deposit: evaluation of the energy resource,Christian Perrin de Brichambaut, Edition: Tech. & Doc. / Lavoisier, 1999.*
5- *Solar Energy Engineering: Processes and Systems,Soteris A. Kalogirou, Edition: Academic Press Inc 2009.*
6- *DP Kothari, KC Singal and RakeshRanjan "Renewable Energy Sources and Emerging Technologies", PHI Lear. Private Ldt (2008)*
7- *J. Duffie, and W. Beckman: Solar Engineering of Thermal Processes, John Wiley & Sons, New York, 1991*
8- *Charles Wereko-Brobby: Biomass Conversion and Technology, John Wiley & Sons, 1996*
9- *BH Khan "Non-Conventional Energy Resources McGraw Hill, 2nd Edn, 2009*
10- *Heliothermal: The solar deposit, methods and calculations, Pierre-Henri Communay, Edition GRE, 2002.*
11- *Solar radiation in the terrestrial environmentAlain Chiron de la Casinière, Edition: Publibook, 2003.*

Semester:x
Teaching unit: UEDxx
Matter :Electronic
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Teach students basic electronics concepts.

Recommended prior knowledge:
General Electricity.

Content of the material:

Chapter 1. Preliminary concepts – Reminders.
Chapter 2. Permanent sinusoidal regime.
Chapter3. The diode and its applications.
Chapter4. The bipolar transistor and its applications.
Chapter5. The linear integrated circuit and its applications.

Evaluation method:
Review: 100%.

Bibliographic references:

Semester: x
Teaching unit: UED xx
Matter :Electrical engineering
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Teach students basic electrical engineering concepts.

Recommended prior knowledge:
General Electricity.

Content of the material:

Chapter 1: Three-phase systems.
Chapter 2 : The transformer.
Chapter 3: Direct current machines.
Chapter 4: Synchronous machines.
Chapter 5: Asynchronous machines.

Evaluation method:
Review: 100%.

Bibliographic references: