الجمهورية الجزائرية الديمقراطية الشعبية

People's Democratic Republic of Algeria

وزارة التعليم العالي والبحث العلمي

Ministry of Higher Education

and Scientific Research

TRAINING OFFER

ACADEMIC MASTERS

NATIONAL PROGRAM
2016 - 2017

Field	Branch	Speciality
Sciences and Technologies	***Mechanical engineering***	**Mechanical Construction**

I – Half-yearly course organization sheets specialty

Semester 1

Teaching unit	Matter	Credit	Coefficient	C	Tutorials	PW	Volume (hour)
Fundamental Unit	continuum mechanics	6	3	3h00	1h30		67h30
	Advanced Strength of Materials	4	2	1h30	1h30		45h00
	Internal combustion engines	4	2	1h30	1h30		45h00
	Applied fluid mechanics	4	2	1h30	1h30		45h00
Methodological unit	PW fluid mechanics/Strength of materials	2	1			1h30	22h30
	Conventional and advanced manufacturing techniques	4	2	1h30		1h30	45h
	Automation of industrial systems	3	2	1h30		1h	37h30
Discovery unit	Optionel subject	1	1	1h30			22H30
	Optionel subject	1	1	1h30			22h30
Transversale Unit	Technical English and terminology	1	1	1h30			22H30

Semester 2

Teaching unit	Matter	Credit	Coefficient	Courses	Tutorials	PW	Volume (hour)
Fundamental Unit	Finite element method	6	3	3h	1h30		67h30
	Advanced dynamics of structures	4	2	1h30	1h30		45h
	Articulated mechanical systems and robotics	4	2	1h30	1h30		45h
	Design of mechanical systems	4	2	1h30	1h30		45h
Methodological unit	PW Finite Elements	2	1			1h30	22h30
	CADM	3	2	1h30		1h	37h30
	Optimization	4	2	1h30		1h30	45h
Discovery unit	Optionel subject	1	1	1h30			22h30
	Optionel subject	1	1	1h30			22h30
Transversale Unit	Ethics, deontology and intellectual property	1	1	1h30			22h30

Semester 3

Teaching unit	Matter	Credit	Coefficient	C	Tutorials	PW	Volume (hour)
Fundamental Unit	Materials	4	2	1h30	1h30		45h
	Dynamics of rotating machines	4	2	1h30	1h30		45h
	Metal frame	2	1	1h30			22h30
	Composite materials	4	2	1h30	1h30		45h
	Fracture mechanics and fatigue	4	2	1h30	1h30		45h
Methodological unit	Methods Office	4	2	1h30		1h30	45h
	Turbomachinery	2	2	1h30		1h	37h30
	Numerical simulation software in mechanics	2	1			1h30	22h30
Discovery unit	Optionel subject	1	1	1h30			22h30
	Optionel subject	1	1	1h30			22h30
Transversale Unit	Literature search and master's thesis design	1	1	1h30			22h30

Discovery TU (S1, S2, S3)

1- Tribology (*)

2- Renewable energies (*)

3- Hygiene and safety

4- Aeronautics

5- Transportation

6- Reliability

7- quality management

8- Collaborative design (*)

9- Theory of solving innovation problems "TRIZ Method" (*)

10- Motion Transformation Mechanisms and Cams (*)

11- Hydraulic and pneumatic systems and devices(*)

12- Welding techniques(*)

13- Non-destructive testing (*)

14- Electronics

15- Electrical engineering

16- Other...

(*) Recommended DTUs

Semester 4

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

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

II - Detailed program by subject of semester S1

Semester: 1
Course unit: FTU 1.1.1
Material: Continuum mechanics
SHV: 67h30 (class: 03h00, tutorial: 1h30)
Credits: 6
Coefficient:3

Teaching objectives:

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

Recommended prerequisites:

Rational mechanics, Materials sciences, Practical work Resistance of materials, Linear algebra, Matrix calculation, Differential equations, Elasticity and Resistance of materials,

Subject content

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

Chapter II: Tensor calculus 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: Deformation tensor **(2 weeks)**

III-1 Motion and its representations
III-2 Deformation of a continuous medium: notion of deformation, Definition of the deformation operator, deformation tensor.
III- 3 Invariants of the strain 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 Principal directions and principal stresses
IV- 5 Tricircles of Mohr IV-6 Special cases of the stress tensor

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

V-1 General form of the constitutive law of an isotropic homogeneous elastic material
V-2 Mechanical characteristics of some isotropic materials

Chapter VI - Strain energy and resistance criteria **(1 week)**

VI-1 Strain energy
VI-2 Resistance criterion: Position of the problem, Von Mises criterion, Tresca criterion

Chapter VII - Solving problems of linear elasticity **(4 weeks)**

VII- 1- Solving using displacement methods (Navier's equations).
VII- 2- Examples of problem solving by displacement methods: torsion of a cylinder, thick cylinder subjected to pressure.
VII- 3 Resolution by the method of the constraints (Method of Beltrami).
VII - 4 Plane elasticity and Airy functions.
VII - 5 Examples of resolution of elasticity problems by Airy's function.

Assessment mode:

Continuous monitoring: 40%; Exam: 60%.

Semester: 1
Course unit: FTU 1.1.1
Material: Advanced material strength
SHV: 45h00 (class: 01h30, tutorial: 01h30)
Credits: 4
Coefficient:2

Teaching objectives:

Address advanced notions of resistance of materials.

Recommended prerequisites:

Strength of material 1

Subject content

Chapter 1: Calculation of stresses in the case of deviated bending **(2 weeks)**

Chapter 2: Determination of displacements and stresses in a bar by energy methods **(3 weeks)**

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

Chapter 4: Limit stress state theories **(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 stress cyclical **(1 week)**

Assessment method :

Continuous assessment : 40%, Exam : 60%.

Semester: 1
Course unit: FTU 1.1.2
Material: Internal combustion engines
SHV: 45h (class: 01h30, 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 their basic dimensioning. Develop the ability to integrate all the disciplines of mechanics to structure the description of internal combustion engines, to master the conceptual aspects and to model their behavior.

Recommended prerequisites:

Knowledge of applied thermodynamics and combustion.

Knowledge of machine kinematics and dynamics.

Subject content

Chapter 1: Organic analysis, thermodynamics and general mechanics (2 weeks)

Chapter 2: Main kinematic chains and functional auxiliaries (2 weeks)

Chapter 3: Thermodynamic cycles, parietal effects, energy flow (2 weeks)

Chapter 4: Respirations: modes operations, suction and supercharging (2 weeks)

Chapter 5: Friction, general architecture, main dimensions (2 weeks)

Chapter 6: Combustibility properties and study of combustion modes (2 weeks)

Chapter 7: Studies of anomalies and optimization of combustion laws combustion (2 weeks)
Chapter 8: Fuel technologies and control of polluting emissions (1 week)

Assessment mode: Continuous monitoring: 40%; Exam: 60%.

References

1. J. B. Heywood, “Internal Combustion Fundamentals”, McGraw Hill Higher Education, 1989.
2. P. Arquès, « Conception et construction des moteurs alternatifs », Ellipse, 2000.
3. J-C. Guibet, « Carburants et moteurs », 1997.
4. P. Arquès, « Moteurs alternatifs à combustion interne (Technologie) », Masson édition, 1987.
5. U.Y. Famin Gorban, A.I., Dobrovolsky V.V, Lukin A.I. et al., « Moteurs marins à combustion interne », Leningrad: Sudostrojenij, 1989, 344p.

6. W. Diamant, « Moteurs à combustion interne », ECAM, 1984.
7. M. Desbois, R. Armao, « Le moteur diesel, Edition Foucher », Paris, 1974.
8. M. Menardon, D. Jolivet, « Les moteurs, Edition Chotard », Paris, 1986.

Semester: 1
Teaching Unit: FTU 1.1.2
Subject: Applied Fluid Mechanics
Total teaching hours: 45h (Class: 01h30, tutorials: 01h30)
Credits: 4
Coefficient: 2

Objectives of the course:

To 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 and dimensioning of structures, components and distribution networks of renewable energy systems. Complementary technical knowledge in applied fluid mechanics for hydraulic networks.

Recommended prerequisites:

Basic knowledge of fluid mechanics.

Develop expertise in the field of analytical and numerical methods in order to understand and use advanced concepts in fluid mechanics.

Analytical and numerical problem-solving work (with the help of commercial software) is used to better understand the theoretical material. Synthesis project.

Course content:

Chapter 1: Review of fluid statics (cases of reservoirs and storage tanks) (1 week)

Chapter 2: Concept of fluid dynamics (review of equations without proof) (1 week)

Chapter 3: Primary and secondary fluid flow regimes (2 weeks)

Chapter 4: Application of conservation laws (mass, momentum, and energy) to these regimes (case of typical problems) (3 weeks)

Chapter 5: Flow in pipes (introduction to Fanno and Reiley flows) (3 weeks)

Chapter 6: Calculation of distribution networks and operating points of a thermodynamic system (3 weeks)

Chapter 8: Hydrodynamic lubrication (2 weeks)

Assessment method:

Continuous control: 40%; Exam: 60%.

Bibliography:

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

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

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

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

Semester 1
Course unit: MTU 1.1.1
Course Title : Practical work: Resistance of materials / fluid mechanics
SHV: 22H30 (PW: 01h30)
Credits: 2
coefficient: 1

Teaching objectives:

Practically illustrate the knowledge acquired in the Resistance of materials / Fluid mechanics course.

Recommended prior knowledge:

Fluid machanics, Resistance of materials.

Content of the subject: according to the existing means

PW Fluid machanics

1. Flow measurement
2. viscosity
3. Center Of Thrust Study
4. Static Fluids
5. flow around an obstacle
6. Pulse of a jet
7. Pressure drops and velocity profiles
8. Study of the influence of the pressure field on a hydrodynamic bearing
9. Effect of the inclination of a plane pad on the pressure distribution

PW Resistance of materials

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

Evaluation mode: Continuous control: 100%.

Semester : 1
Course unit : MTU 1.1
Subject : Conventional and advanced manufacturing techniques
SHV : 45h (Lectures : 01h30, PW : 01h30)
Credits : 4
Coefficient : 2

Teaching objectives :

The objective of this course is to teach the student the various processes for obtaining parts. It aims to introduce the student to new techniques that are necessary for shaping specific parts.

Recommended prior knowledge :

Industrial drawing, general mechanics.C

Content of the course :

Part I

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

Part II

1. Electroerosion
2. Sintering
3. Photochemical machining
4. Laser machining
5. Explosive forming
6. Electro-hydraulic forming
7. Electromagnetic forming

Assessment method :

Continuous assessment : 40%, Exam : 60%.

Bibliographical references :

1. *Claude Corbet, Mémotech - Procédés de mise en forme des matériaux, Editeur(s) : Casteilla, Collection : Mémotech, 2005.*
2. *M. Ashby, Y. Bréchet, L. Salvo, selection des materiaux et des procedes d e mise en œuvre, Vol. 20 du Traité des Matériaux, Presses polytechniques et universitaires romandes, 2001.*
3. *Eric FELDER, Mise en forme des métaux - Aspects mécaniques et thermiques, Techniques de l'Ingénieur, Référence M3000 v2, 2015.*
4. *Éric FELDER, Lubrification en mise en forme - Principes généraux et choix, Techniques de l'Ingénieur, Référence M3015 v1, 2006.*
5. *SUÉRY Michel, Mise en forme des alliages métalliques à l'état semi-solide, Hermes, Lavoisier, 2002.*
6. *Battaglia Jean-Luc, Transferts thermiques dans les procédés de mise en forme des matériaux : cours et exercices corrigés, Paris Hermes science publ. 2007 Lavoisier.*
7. *L. Rimbaud, G. Layes, J. Moulin, Guide Pratique de l'usinage, Hachette Technique, 2006.*
8. *J. SAINT-CHELY, "choix des outils et des conditions de coupe en tournage", 1993.*
9. *Pierre Bourdet. La coupe des métaux. Cours Ecole normale supérieure de Cachan, Ver 5 2004*
10. *J. Jacob, Y. Malesson, D. Ricque, Guide pratique de l'usinage 2 : Tournage, Hachette Techniques.*
11. *François BAGUR, Matériaux pour outils de coupe, Techniques de l'Ingénieur, Référence BM7080 v1, 1999.*
12. *Eric FELDER, Modélisation de la coupe des métaux, Techniques de l'Ingénieur, Référence BM7041 v1, 2006.*

Semester : 1
Course unit : MTU 1.1
Subject : Automation of industrial systems
SHV : 37h30 (Lectures : 01h30, PW : 01h00)
Credits : 3
Coefficient : 2

Teaching objectives :

The assimilation of fundamental knowledge in the field of automation, and the acquisition of the notions necessary for the control of industrial processes. 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 course :

Chapter 1: Introduction, control systems, supervision systems, ManufacturingExecution system (MES). **(2 Weeks)**

Chapter 2: Automated Systems (Industrial Control and Command) **(3 Weeks)**

- Introduction
- Objective of the automation of industrial systems
- Profitability of an automation
- Life cycle of an industrial system
- Modular design
- Location

Chapter 3: Supervision Systems **(4Weeks)**

- Role of a supervision system
- Design of supervision applications

Chapter 4: Structure of Programmable Logic Controllers **(4Weeks)**

- role of an automaton, principles of programmable logic,
- principle of the programmable automaton,

Production technology

- virtual programmable logic controllers (Soft PLC)

Chapter 05: Industrial Interface and Safety Devices **(2 Weeks)**

Assessment method :

Continuous assessment : 40%, Exam : 60%.

Semester 1
Course unit: TTU 1.1
Subject 1: Technical English and Terminology
SHV: 22H30 (course: 01h30)
Credits: 1
coefficient: 1

Teaching objectives :

Introduce the student to technical vocabulary. Strengthen his knowledge of the language. Help him to understand and synthesize a technical document. Allow him to understand an English conversation held in a scientific setting.

Recommended prerequisites:

Basic vocabulary and grammar in English

Content of the subject:

- Written comprehension: Reading and analysis of texts related to the specialty.

- Oral comprehension: Using authentic scientific extension 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, CV writing, letters of applications for internships or jobs.

Recommendation: It is strongly recommended that the Subject Matter Lead present and explain at the end of each session (maximum) a dozen technical words of the specialty in all three languages (if possible) English, French and Arabic.

Evaluation method:

Examination: 100%.

III - Detailed program by subject of semester S2

Semester : 2
Course unit : FTU 1.2.1
Subject : Finite element method
SHV : 67h30 (Lectures: 03h00, Tutorials : 1h30)
Credits : 6
Coefficient : 3

Teaching objectives :

To present the finite element method and the modern solution methods which make it possible to deal with linear and nonlinear problems, one- and two-dimensional field problems, non-stationary field problems and problems of solid mechanics

It is mainly intended for students who wish to develop comprehensive skills in finite element methodology, from fundamental concepts to practical computational implementations.

Recommended prior knowledge :

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

Content of the course:

Chapter 1: Basic Concepts (2 weeks)

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

Chapter 2: Linear elements of structures (4 weeks)

1- Linear and spiral spring elements.
2- Elastic bar elements
3- Truss systems
4- Beam elements

Chapter 3: Elements of two-dimensional structures (3 weeks)

1- Introduction
2- Plane stresses, plane strains and stress-strain relations
3- Triangular and rectangular flat 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: Elements of three-dimensional structures (3 weeks)

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

Chapter 6- Complementary formulations (3 weeks)

 Finite element techniques
- Mesh design
- Distortion
- How to choose a mesh
- convergence
 Material nonlinearity
- Elastoplasticity
- Elastoplastic behavior
- Solving techniques
 Thermal issues

Assessment method :

Continuous assessment : 40%, Exam : 60%.

Semester : 2
Course unit : FTU 1.2.1
Subject : Advanced dynamics of structures
SHV : 45h00 (Lectures: 01h30, Tutorials : 1h30)
Credits : 4
Coefficient :2

Teaching objectives :

This course aims to determine and solve the equation of motion of structures (free, forced, damped undamped, etc.). The knowledge of the various responses due to the various loadings informs us about the modes of vibrations and the possibilities of their dampings.

Recommended prior knowledge :

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

Content of the course:

Chapter 1 Reminders of kinetics, dynamics (2 weeks)

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

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

II.1 Undamped free oscillations
II.2 The coefficient of stiffness of some systems
II.3 Damped free oscillations
II.4 Applications

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

III.1General
III.2 Forced oscillations due to harmonic loading
III.3 Forced oscillations due to half-sine impulsive loading
III.4 Forced oscillations due to Spectral loading - integral of DUHAMEL
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 Beam vibrations.
IV.4 Vibration of membranes.

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 VI Numerical methods applied to the dynamics of structures (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

Assessment method :

Continuous assessment : 40%, Exam : 60%.

Semester : 2
Course unit : FTU 1.2.2
Subject : Articulated mechanical systems and robotics
SHV : 45h (Lectures: 01h30, Tutorials : 1h30)
Credits : 4
Coefficient : 2

Teaching objectives :

To be able to model a simple mechanism as a system of rigid and undeformable solid bodies, and to be able to solve associated problems of statics, kinematics, and dynamics.

Recommended prior knowledge :

Basic knowledge of solid mechanics, kinetics and dynamics of rigid bodies, theory of mechanisms, and wrenches.

Content of the course:

Chapter I: Introduction to Robotics **(1 week)**

Definitions and Terminology

Types of Architectures: Serial Robots, Parallel Robots, Mobile Robots, Flexible Robots, Walking Robots, etc.

Chapter II: Parametrization 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 Formulation, Newton-Euler Formulation) **(3 weeks)**

Chapter VI: Motion Generation **(2 weeks)**

Chapter VII: Introduction to Medical Robotics and Assistance for People with Reduced Mobility **(2 weeks)**

Mini-project: Modeling a robot for a specific task, determining its workspace, and optimal placement of a robot

(21 days, remote work)

Alternatively,

a lab project could involve programming a robot for tasks such as point tasks, continuous tasks, and pick-and-place operations.

Assessment method :

Continuous assessment : 40%, Exam : 60%.

Bibliographical references :

1. *Modélisation, identification et commande des robots, Wisama Khalil et Etienne Dombre ; Herrmes Lavoisier 1999.*
2. *Théorie des mécanismesparfaits : outils de conception auteur(s) : leroy Lavoisier 1998*
3. *Théorie simplifiée des mécanismes élémentaires* ***auteur :****loche l.-e. Dunod 2001*
4. *J. P. Lellmend et Said Zeghloul " Robotique aspects fondamentaux Masson 1991.*
5. *Théorie des mécanismes parfaits : outils de conception auteur(s) : leroy Lavoisier 1998*
6. *A. Pruski Robotique générale. Ellipses 1988*
7. *P. André Traité de robotique T4 : Constituants technologiques. Hermes 1986*
8. *M. Cazin et J. Metje Mécanique de la robotique Dunod 1989*
9. *Jack Guittet La robotique médicale. Hermes 1998.*
10. *Saeed Benjamin Niku, « Introductionto 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 AppliedRobotics - Kinematics, Dynamics, and Control »,Library of Congress, 2007.*

Semester : 2
Course unit : FTU 1.2.2
Subject : Design of mechanical systems
SHV : 45h (Lectures: 01h30, Tutorials : 1h30)
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. Dimension mechanisms. Deepen the technological knowledge of certain mechanical systems.

Recommended prior knowledge :

strength of materials, Mechanisms, machine elements.

Content of the course:

Chapter 1. Functional Analysis Overview: (1 Week)

(Definition, Product, System, User, Product Environment, Product Development Process, Life Cycle, Life Situation, Scope, external functional analysis, internal functional analysis, examples).

Chapter 2. Functions: (1 Week)

(Definition, formulation of functions, main service function, complementary function, constraint function, technical function, examples).

Chapter 3. Functional analysis approach: (1 week)

(Expression of need, inventory, scheduling, characterization, hierarchy, "Octopus" diagram, applications).

Chapter 4. Functional specifications: (1 week)

(Definition, criteria, level, flexibility, value analysis approach, writing).

Chapter 7. Application to the kinematic chain of a vehicle: (3 Weeks)

Chapter 8. Application to the kinematic chain of a machine tool: (3 Weeks)

Chapter 9. Application to the kinematic chain of a lifting device : (2 Weeks)

Chapter 10. Application to the complete design of a machine component: (3 Weeks)

Evaluation mode: Continuous Control: 40%, **Exam:** 60%.

Semester: 2
Teaching unit: MTU 1.2
Subject: Practical work Finite elements
SHV: 22h30 (PW: 01h30)
Credits: 2
Coefficient: 1

Teaching objectives:

Know how to model and simulate on software or finite element calculation code.

Recommended prior knowledge:

Formulation and Calculation by finite elements

Subject content :

1- Practical work on the springs; bars, beam

2- Practical work on flat elements

- Analytical formulation of elements Q4, T3, by Scientific mathematical software and determination of the elementary stiffness matrix as well as the assembly of these matrices.

- Modeling of the beams in 2 D by elements Plans Q4 and T3 on Software (Abaqus, Ansys, RDM6,…..) and comparison with the existing analytical solutions.

3- Practical work with Software (Abaqus, Ansys, …….) on axisymmetric elements (cylinder under internal pressure)

4- Practical work with Software (Abaqus, Ansys, …….) on Vibration of beams modeled by membrane elements (Example CPS4 and CPS3 of the Abaqus code) and plates modeled by plate elements (Example S4R of the Abaqus code).

5- Practical work on heat transfer on computer code (Abaqus, Ansys….).

6- Practical work with software (Abaqus, Ansys, …….) on plastic calculation of two- and three-dimensional structures.

7- Programming by Fortran or Matlab of the Q4, T3, Bar and Beam elements.

Evaluation mode: Continuous control: 100%

Semester : 2
Course unit : UEM 1.2
Subject : CAD/CAM
SHV : 37h30 (Lectures 1h30, TW : 1h00)
Credits : 3
Coefficient : 2

Teaching objectives :

The aim is to improve students' knowledge in the field of Computer-Aided Manufacturing (CAM). At the end of the semester, students will be expected to acquire the following skills:

• Modeling of complex-shaped parts (molds, matrices, etc.).

• Simulation of the machining process.

• Interpretation and verification of automatically generated machining programs.

During the practical sessions, students will be required to master a CAM software to design complex parts and assemblies, as well as simulate the machining of the designed parts. If the available resources allow it, the student should visit the workshop to execute the generated program on a computer numerical control (CNC) machine.

Recommended prior knowledge :

Mathematics, CAD, basic knowledge of computer-aided design and conventional mechanical manufacturing (conventional machining).

Content of the course :

Chapter 1. Overview: (1 Week)

(Definition of CAD/CAM, product development process, elements of a CAD system, elements of a CAM system, CAD/CAM software).

Chapter 2. Curve modeling: (3 Weeks)

(Introduction, smoothing and interpolation, mathematical and geometric continuity, Bezier curves, B-spline curves, NURBS curves, examples).

Chapter 3. Surface modeling: (3 Weeks)

(Introduction, Bezier patches, continuity, B-spline patches, NURBS patches, examples).

Chapter 4. Solid modeling: (1 Week)

(Introduction, decomposition modeling, Boolean operations, boundary representation modeling "B-Rep", constructive solid geometry modeling "CSG", exchange formats).

Chapter 5. CNC Machines: (1 Week)

(Introduction, major components, areas of use, standardized axes, origins, axis control, different architectures of CNC machines).

Chapter 6. ISO Programming: (4 Weeks)

(Introduction, CNC program structure, major preparatory functions, major auxiliary functions, cutting parameters, predefined cycles, examples).

Chapter 7. Toolpath generation: (2 Weeks)

(Introduction, machining strategies, longitudinal and transverse steps, tolerances, discontinuities, and interference).

Lab sessions: should take place in a computer room equipped with either a CAD/CAM software or separate CAD and CAM software. The lab sessions should be divided into two parts:

CAD part: (7 weeks)

- Creation of complex-shaped parts (using splines and surfacing tools). Saving in a neutral format.
- Assembly creation.
- Determination of mass characteristics of parts and assemblies.
- Creation of molds and dies.
- Static simulation (quick calculation of stresses and deformations).
- Drawing creation of parts and assemblies (title block, bill of materials, annotations).
- Kinematic and dynamic simulation (position, velocity, acceleration, trajectory, force, torque, power).

CAM part: (8 weeks) Simulation of part machining by following the steps below:

- Modeling of the finished part (or opening it if it is already designed).
- Modeling of the raw material (or opening it if it is already designed).
- Selection of the machining type (turning, prismatic machining, surfacing, etc.).
- Selection of the machine (horizontal lathe, vertical lathe, 3-axis milling machine, 5-axis milling machine, etc.).
- Selection of the reference system.
- Selection of the finished part and the raw material.
- Selection of a safety plane.
- Selection of the machining type (roughing, pocketing, surfacing, contouring, curve following, sweeping, drilling, facing, turning, etc.).
- Selection of the surfaces to be machined (in the case of turning, they will be the generatrices).
- Selection of the cutting tool.
- Determination of cutting conditions (cutting and feed speeds).

- Selection of the machining strategy (zigzag, back-and-forth, single direction, etc.).
- Selection of the axial and radial passes (if applicable).
- Setting of approach and retreat macros.
- Execution of the simulation (generation of toolpaths).
- Visualization of the generated video.
- Determination of machining time.
- Selection of the post-processor.
- Generation of G-code machining program.
- Reading and verification of the generated program.

For the CAM part, simple-shaped parts (prismatic and cylindrical) should be used at the beginning in order to experiment with the effect of varying different selected parameters (cutting conditions, machining strategies, cutting tools, radial and axial passes, approach and retreat macros, etc.); the verification of the generated machining program will also be easier. Later on, complex-shaped parts can be processed.

Assessment method:

Continuous assessment : 40%, Exam : 60%.

Bibliographical references :

1. JEAN-CLAUDE LEON, "Modélisation et construction de surfaces pour la CFAO",
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, "Fabrication assistée par ordinateur", Ed. Lavoisier Hermès-science, Paris, 2003.
10. PETER SMID, "CNC Programming Handbook", Ed. Industrial Press Inc., 2007.
11. JEAN VERGNAS, "Exploitation des machines-outils à commande numérique", Ed. Pyc, 1985.
12. CLAUDE HAZARD, "La commande numérique des machines-outils", Ed. Foucher, 1984.
13. CLAUDE MARTY, CLAUDE CASSAGNES, PHILIPPE MARIN, "La pratique de la commande numérique des machines-outils", Ed. Tec & Doc, 1993.
14. A. CORNAND, F. KOLB, "Usinage et commande numérique", Ed. Foucher, 1987.
15. P. GONZALEZ, "La commande numérique par calculateur : tournage, fraisage, centred'usinage", Ed. Casteilla, Paris, 1993.
16. Documentation du logiciel CATIA, "Catia Lathe Machining", "Catia Prismatic Machining", "Catia Advanced Machining".

Semester: 2
Teaching unit: MTU 1.2
Subject: Optimization
SHV: 45h00 (course: 01h30, PW:1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
Become familiar with operational 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.

Subject content :

Chapter I: Linear Optimization **(3 weeks)**
- General formulation of a linear program
- Examples of linear programs (Production problem, Mixing problem, Cutting problem, Transport problem)
- Resolution of the problem by 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 constraints **(5 weeks)**
- Positivity, Convexity, Minimum
- Gradient and Hessian
- Necessary conditions for a minimum
- Sufficient conditions for a minimum
- Local methods
- One-dimensional research methods
- Gradient methods
- Methods of conjugate directions
- Newton's method
- Quasi-Newton methods

Chapter III: Non-linear 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 the practicals: it is preferable that the practicals are direct applications in the field of mechanical construction.

Practical work 1: presentation of optimization reference functions in Matlab
Practical work 2: Presentation of the optimization tool optimtool in matlab
Practical work 3: Definition and plotting of the curves of some test functions in optimization
Practical work 4: Solving a linear optimization problem without constraints
Practical work 5: Solving a linear optimization problem with constraints
Practical work 6: Nonlinear minimization without constraints
Practical work 7: Nonlinear minimization without constraints with gradient and Hessian
Practical work 8: Nonlinear minimization with equality constraints
Practical work 9: Nonlinear minimization with inequality constraints
Practical work 10: Minimization with equality and inequality constraints
Practical work 11: Use of the optimtool or other tool to solve a nonlinear optimization problem with constraints
Practical work 12: Minimization with constraints using the GA function

Assessment method: Continuous assessment: 40%; Exam: 60%.

Semester: 2
Teaching unit: TTU 1.2
Subject: Ethics, deontology and intellectual property
SHV: 22h30 (course: 01h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Develop student awareness of ethical principles. Introduce them to the rules that govern life at the university (their rights and obligations vis-à-vis the university community) and in the world of work. Make them aware of the respect and valuation of intellectual property. Explain to them the risks of moral evils such as corruption and how to combat them.

Recommended prior knowledge:

None

Subject content :

A- Ethics and deontology

I. Notions of Ethics and Deontology (3 weeks)

1. Introduction
    1. Definitions: Morality, ethics, deontology
    2. Distinction between ethics and deontology
2. Charter of ethics and professional conduct of the MHESR: Integrity and honesty. Academic freedom. Mutual respect. Requirement of scientific truth, objectivity and critical thinking. Equity. Rights and obligations of the student, teacher, administrative and technical staff.

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

II. Integrity and responsible research (3 weeks)

1. Respect for the principles of ethics in teaching and research
2. Responsibilities in teamwork: Professional equality of treatment. Conduct against discrimination. The search for the general interest. Inappropriate conduct in the context of collective work
3. Adopting responsible conduct and combating excesses: Adopting 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.

B- Intellectual property

I- Fundamentals of intellectual property (1 week)

1- Industrial property. Literary and artistic property
2- Rules for citing references (books, scientific articles, conference papers, theses, dissertations, etc.)

II- Copyright (5 weeks)

1. Copyright in the digital environment
Introduction. Database copyright, software copyright. Specific case of free software.

2. Copyright in the internet and electronic commerce
Domain name rights. Intellectual property on the internet. Law of the e-commerce site. Intellectual property and social networks.

3. Patent
Definition. Rights in a patent. Usefulness of a patent. Patentability. Patent application in Algeria and worldwide.

4. Trademarks, designs and models
Definition. Trademark Law. Design law. Denomination of origin. The secret. Counterfeit.

5. Geographical Indication Law
Definitions. Protection of Geographical Indications in Algeria. International Treaties on Geographical Indications.

III- Protection and enhancement of intellectual property (3 weeks)
How to protect intellectual property. Violation of rights and legal tool. Valuation of intellectual property. Protection of intellectual property in Algeria.

Assessment method:
Examination: 100%

IV - Detailed program by subject of semester S3

Semester: 3
Teaching unit: FTU 2.1.1
Module: Materials
SHV: 45h00 (Course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching Objectives:

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

Recommended Prior knowledge:

Materials science and general and mineral chemistry

Course Content:

Chapter 1. Reminder: 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 alloys phase diagrams, liquid-solid and solid-liquid transformation, Applications to ferrous and light alloys / solid state transformations with and without diffusion / Adaptation of metallic materials to their use.

- Heat treatments: Quenching (TTT and CCT curves, critical quenching speed), tempering, materials aging, annealing (applications to steels and light alloys) / Thermochemical treatment (cementation, nitriding) and mechanical treatment (roller burnishing, shot-blasting). Corrosion protection, corrosion mechanisms, coatings.

Chapter 3: Non-metallic Materials

- Polymeric materials (organic): specific characteristics to plastics in relation to their structure - distinction between families of polymers (thermosetting, thermoplastics and elastomers), mechanical behavior: (importance of the role of temperature and time) - forming - degradation, aging, sensitivity to solvents.

- Ceramic materials: specific characteristics to ceramics in relation to their nature, mechanical behavior – forming.

- Composite materials: Association of materials – anisotropy - forming processes - assembly and machining problems, specificities of mechanical behavior.

Chapter 4: 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 / Data sources on materials (bibliography, database) / Selection criteria based on costs, availability, conditions of use and manufacture/ Selection of materials / Awareness of the existence of assistance tools to the selection of materials / Case study.

Evaluation Method: Continuous evaluation: 40% + Exam: 60%.

Bibliographic references:

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

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

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

4. Science et génie des matériaux, parWilliam-D et Jr Callister, Editions Modulo, 2001

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

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

7. Caractérisation expérimentale des matériaux I (TM volume 2) : Propriétés physiques, thermiques et mécaniques, par Suzanne Degallaix et Bernhard Ilschner, Collection

PPUR (Presses Polytechniques Universitaires Romandes), 2007.

Semester: 3
Teaching unit: FTU 2.1.1
Module: Dynamics of rotating machines
SHV: 45h00 (Course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching Objectives:

- Review vibration modeling techniques for rotating machines
- Master the methods of numerical resolution and choose the appropriate modeling
- Allow better control of the installation and use of rotating machinery
- Understand applications on industrial machines particularly sensitive to vibrational alterations of their components

Recommended Prior knowledge:

(Mathematical calculation, prerequisite finite elements, resistance of materials and dynamics of structures).

Course Content:

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, Symmetric and asymmetric rotor, instability, damped rotors.

3- Modeling of rotors by finite elements

4- Rotor torsional vibrations

5- Influence of bearings on rotor vibrations

6- Balancing the rotors

Evaluation Method: Continuous evaluation: 40% + Exam: 60%.

Semester: 3
Teaching unit: FTU 2.1.1
Module: metal frame construction
SHV: 22h30 (Course: 1h30)
Credits: 2
Coefficient: 1

Teaching Objectives:

Understand the basics of metal frame construction design.

Recommended Prior knowledge:

Materials science, mechanical construction

Course Content:

Chapter 1 **(3 weeks)**

General criteria of a metal frame construction design.

Chapter 2 **(4 weeks)**

Industrial warehouse design and calculation

Chapter 3 **(3 weeks)**

Design of multi-storey steel structure

Chapter 4 **(3 weeks)**

Base plates and column base connection

Chapter 5 **(2 weeks)**

Constructive provisions and execution details

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

Bibliographic references: *(Books, websites, etc.).*

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

Semester: 3
Teaching unit: FTU 2.1.2
Module: Composite materials
SHV: 45h00 (Course: 1h30, Tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching Objectives:

Know the new composite and heterogeneous materials and their applications.

Recommended Prior knowledge:

Knowledge of materials science, continuum mechanics and production techniques.

Course Content:

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

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

II. 1. obtaining fibers (glass, carbons, aramids, boron, etc.)

II.2. Organic and polymer matrices.

II. 3. Manufacture of composites.

- "Contact" molding
- Projection molding
- Filamentary winding
- Pultrusion
- The compression
- Injecting
- Prepreg draping.

Chap III Mechanical properties of composites (03 weeks).

- Micromechanical homogenization - **Law of mixtures** - Determination of the elastic properties of an orthotropic ply.

- Longitudinal modulus of elasticity
- Transverse modulus of elasticity
- Shear modulus
- Poisson coefficient

Chap 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 apart from the axes of orthotropy
- Behavioral law of a multilayer laminate

Chap V thermomechanical behavior of a unidirectional composite (01 weeks).

Chap VI flexural behavior of composite laminates (03 weeks).

» Bending of thin plates (Kirchoff hypothesis)

» Bending of thick plates with transverse shear (Mindlin hypothesis)

» Bending Sandwich Plates

Chap VII Ruptures and damage to composites (02 weeks).

- Damage to composites and means of control.
- Composite failure criteria (conventional and interactive criteria)

Evaluation mode :

Continuous assessment: 40%; Exam: 60%.

Semester : 3
Teaching unit: FTU 2.1.2
Matter : Fracture mechanics and fatigue
SHV: 45h (Lesson: 1h30, tutorials: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives :

The objective of the fracture mechanics course is to provide computational and analytical methods for optimizing the design of structures by taking into consideration the following concepts: follow-up, reliability and economics. It also offers a rigorous control of structures sensitive to unpredictable aggressions of cracks.

Recommended prior knowledge :

Materials and numerical methods.

Matter content :

Chapter I : Structure, materials and properties **(1 week)**

Chapter II : Fatigue of materials **(3 weeks)**

Chapter III: Linear fracture mechanics **(4 weeks)**

Chapter VI: Study of material behavior in the vicinity of a crack **(4 weeks)**

Chapter V: Laws of fatigue cracking **(3 weeks)**

Evaluation mode :

Continuous assessment: 40%; Exam: 60%.

References:

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

2- Alain Cardou, Plasticité, fatigue et rupture des matériaux métalliques : modèles mécaniques, Editeur : Loze-Dion éditeur, 2006.
3- Dominique François, André Pineau, André Zaoui, Viscoplasticité, endommagement, mécanique de la rupture et mécanique du contact, Hermes – Lavoisier, 2009.
4- Claude Bouhelier, Mécanique de la rupture seuil de propagation, propagation des fissures par fatigue, Éditeur : CETIM – Centre Technique des Industries Mécaniques, 1989.
5- RECHO Naman, Mécanique de propagation et de bifurcation des fissures, HERMES SCIENCE PUBLICATIONS / LAVOISIER, 2012.
6- Clément Lemaignan, La rupture des matériaux, Editeur : Edp Sciences, 2003.
7- Dominique François, Endommagement et rupture de matériaux, Editeur : Edp Sciences, 2004.

Semester: 3
Teaching unit: MTU 2.1
Subject: Methods Office
SHV: 45h00 (Course: 1h30, PW: 01h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The methods office is the interface between the manufacturing or production workshops and the design offices. Indeed, the roles and missions of a methods office particularly allow verification, with the design office, of the feasibility and manufacturability of a product. The main objective of the teaching provided is to initiate students to develop a manufacturing process by taking into consideration the definition drawing of the product, the type of production as well as the means and tools essential for the realization. The purpose 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 essential that these projects integrate, in line with production costs, the scheduling of the various machining operations and their grouping into sub-phases and phases, the judicious choice of machine tools and tools and the calculation of machining.

Recommended prior knowledge:

Industrial Design, Basic Technology, Mechanical Manufacturing, Materials Science, Mechanical Manufacturing PW, Conventional and Advanced Manufacturing Techniques.

Subject content:

Course program

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 methods office
I-3 Analysis of the definition drawing.
I-4 Notions of form and position tolerances.
I.4.1. Indication of a reference element
I.4.2. Entry of the tolerance value
I.4.3. Registration of references
I.4.4. Shape 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 pick-up.

II.2.1. Rules for choosing the layout

II-3 Technological and geometric symbolization.

II.3.1. Technological symbolization

II.3.2. Type of technology

II.3.3. Nature of the spotted surface

II.3.4. Function of the technological element

II.3.5. Nature of the contact surface

II.3.6. Notion of normal

II.3.7. Normalized Representation

II.3.8. Elementary links

II-4 Choice of positioning surfaces.

II.4.1. Fundamental principle

II.4.2. Rules of choice

II.4.2.1. Rule 1

II.4.2.1. Rule 2

II.4.2.1. Rule 3

II-5 Examples of application.

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 (Md)

III.1.4.2. Apparatus dimensions (Ad)

III.1.4.3. Tool dimensions (Td)

III.1.4.4. Notion of auxiliary adjustment reference

III.1.4.5. Advice

III-2 Dimension transfer

III.2.1. Definitions

III.2.1.1. Direct dimension

III.2.1.2. Dimension transferred

III.2.1.3. Dimensions-methods

III.2.1.4. Conditions dimension CD

III.2.1.5. Economic tolerances

III.2.2. Example of dimension transfer

III.2.3. Conventions Adopted for Drawing the Transfer Graph

III.2.4. Methods of Calculating a dimension Transfer

III.2.4.1. Method of limit dimensions

III.2.4.2. Mean dimension method

III.2.4.3. Total Transfer Calculation

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

IV- Basic operations and anteriorities due to machining constraints **(2 weeks)**

IV -1 Elementary machining operations: turning, milling, drilling, boring, 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 Anteriorities due to machining constraints: dimensional, geometric and technological.

IV.2.1 Constraints of dimensional specifications (quotation)
IV.2.1.1 Connection between a raw surface and a machined surface
IV.2.1.2 Connection between machined surfaces
IV.2.1.3 Associated machined surfaces
IV.2.2 Constraints of geometric specifications (of order)
IV.2.2.1 Shape tolerances
IV.2.2.2 Orientation tolerances
IV.2.2.3 Position tolerances
IV.2.2.4 Example of 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 Basic operations
IV.2.4.2 Keyway
IV.2.4.2 Intersecting bores
IV.2.4.3 Countersunk 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 blank
V.2.1 Part Assumptions
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 anteriorities of machining operations.
V-5 Matrix method for establishing the machining order.
V-6 Grouping of phase and sub-phase machining operations.
V-7 machining rang project.
V-8 Contract of the different machining phases and choice of cutting regime.
V-9 Examples of machining rang for toothed wheels .

Program of Tutorials (or Practical Works) **(1h30 / week)**

• Tutorial (PW) n°1: Analysis of a definition drawing of a given part.
• Tutorial (PW) n°2: Analysis of the positioning of a part with the use of geometric and technological symbolization.
• Tutorial (PW) n°3: Analysis of a manufacturing quotation (dimensional).
• Tutorial (PW) n°4: Analysis of a manufacturing quotation (geometric).
• Tutorial (PW) n°5: Performing a dimension transfer from a definition drawing for a given machining operation.
• Tutorial (PW) n°6: Study of basic turning operations with determination of the cutting speed.
• Tutorial (PW) n°7: Study of basic milling operations with determination of the cutting speed
• Tutorial (PW) n°8: Study of basic drilling/boring operations with determination of the cutting speed
• Tutorial (PW) n°9: Study of machining anteriorities for a given part.
• Tutorial (PW) n°10: Analysis and determination of the number of machining operations, for a given part, according to the quality and the state of the surface.
• Tutorial (PW) n°11: Matrix method for establishing the order of machining for a part of revolution.
• Tutorial (PW) n°12: Matrix method for establishing the machining order for a part of any shape.
• Tutorial (PW) n°13: Machining range project for a revolution part.
• Tutorial (PW) n°14: Draft machining plan for a part of any shape.
• Tutorial (PW) n°15: Analysis of phase contracts for a revolution part.

Assessment method:

Continuous assessment: 40%, Examination: 60%.

Semester: 3
Teaching Unit: UEM 2.1
Subject: Turbomachines
VHS: 37h30 (Lecture: 1h30, TP: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives:

The course aims to familiarize the student with the functioning and energy calculation of a turbomachine. To this end, thermodynamics concepts are applied to turbomachinery to calculate the different efficiencies and performances.

Recommended prerequisite knowledge:

Basic knowledge of thermodynamics and fluid mechanics is required.

Course content:

I. General definitions of turbomachinery (1 week)

II. Similarities in turbomachinery (2 weeks)

III. Pumps (3 weeks)

- Centrifugal pumps
- Axial pumps
- Velocity triangles
- Power and efficiencies

IV. Cavitation in pumps (2 weeks)

V. Coupling of centrifugal pumps (1 week)

VI. Dimensioning of centrifugal pumps (2 weeks)

VII. Hydraulic turbines (3 weeks)

Pelton turbine, Francis turbine, Kaplan turbine

Assessment method:

Continuous Control: 40%, Exam: 60%.

References:

1) Dixon (1998), Fluid mechanics and thermodynamics of turbomachinery, 4t ed Butterworth-Heinemann

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

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

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

Semester: 3
Teaching unit: MTU 2.1
Subject: Numerical simulation software in mechanics
SHV: 22h30 (PW: 01h30)
Credits: 2
Coefficient: 1

Teaching objectives:

Get an idea of numerical simulation software in mechanics and teach students the practical resolution of some problems.

Recommended prior knowledge:

Notions of general mechanics and computer science

Subject content:

Choice of one (or more) numerical simulation software in mechanics and give some examples of problems:

- **Practical work N°1**: Problem of linear statics 1D (Bar, beam). **(1 week)**
- **Practical work N°2**: Problem of linear statics 2D (Plane stresses, plane strains). **(1 week)**
- **Practical work N°3:** Problem of linear statics 3D (Tetrahedral elements, cubic elements). **(1 week)**
- **Practical work N°4:** Geometric nonlinearity (Large deformation, buckling). **(2 weeks)**
- **Practical work N°5:** Non-linearity of the material (plastic deformation, creep, viscoelasticity). **(2 weeks)**
- **Practical work N°6**: Contact problem. **(1 week)**
- **Practical work N°7**: Thermomechanical problem. **(1 week)**
- **Practical work N°8**: Anisotropic material (Composite materials). **(2 weeks)**
- **Practical work N°9**: Calculation of the natural frequencies of a structure. **(1 week)**
- **Practical work N°10**: Harmonic analysis of a structure. **(1 week)**
- **Practical work N°11**: Rigid dynamic analysis. **(1 week)**
- **Practical work N°12**: Heat transfer in transient state. **(1 week)**

Assessment method:
Continuous assessment: 100%,

Semester: 3
Teaching unit: TTU 1.3
Matter : Documentary research and master's thesis design
SHV: 22h30. (C : 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Give the student the necessary tools to find useful information to better use it in his graduation project. Help him through the different steps leading to the writing of a scientific document. Make him aware of the importance of communication and teach him to present the work carried out in a rigorous and educational manner.

Recommended prior knowledge:

Writing methodology, Presentation methodology.

Content of matter:

Part I-: Documentary research:

Chapter I-1: Definition of the subject (02 Weeks)

- Subject title
- List of keywords concerning 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: Selecting sources of information (02 weeks)

- Type of documents (Books, Theses, Dissertations, Periodical articles, Conference proceedings, Audiovisual documents, etc.)
- Type of resources (Libraries, Internet…)
- Assess the quality and relevance of information sources

Chapter I-3: Locating documents (01 Week)

- Research techniques
- Search operators

Chapter I-4: Processing information (02 weeks)

-Work organization

- The starting questions

- Summary of selected documents

- Links between different parties

- Final plan of the documentary research

Chapter I-5: Presentation of the bibliography (01 Week)

- The systems for presenting a bibliography (The Harvard system, The Vancouver system, The mixed system, etc.)

- Presentation of documents.

- Citation of sources

Part II: Thesis Design

Chapter II-1: Dissertation plan and stages (02 weeks)

- Identify and delimit the subject (Summary)

- Issues and objectives of the dissertation

- The other useful sections (Acknowledgements, Table of abbreviations, etc.)

- The introduction (Writing 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 (02 weeks)

-Formatting. Numbering of chapters, figures and tables.

-Cover Page

- Typography and punctuation

-Writing. Scientific language: style, grammar, syntax.

- Spelling. Improved general linguistic competence in terms of comprehension and expression.

- Save, secure, archive your data.

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

Chapter II-4: Oral presentations and defenses **(01 Week)**

- How to present a Poster

- How to present an oral communication.

- Defense of a dissertation

Chapter II-5: How to avoid plagiarism? **(01 Week)**

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

-The quote

- The paraphrase

- Indicate the complete bibliographic reference

Evaluation mode:

Continuous Control: 100%.

Proposal of some discovery subjects

Semester: X
Teaching unit: DTU X.X
Subject: Tribology
SHV: 22h30 (Course: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

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

Recommended prior knowledge:

Rational Mechanics, Strength of Materials, Basic Technology, Materials Science and Elasticity.

Course program

I- Introduction to tribology **(2 weeks)**

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

II- Friction study **(4 weeks)**

- Origin of frictional force
- The different types of friction (sliding, rolling and pivoting)
- Phenomena of adhesion and friction - Coefficient of static and kinetic friction
- 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 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)

Assessment method:

Exam: 100%

Semester: X
Course unit: DTU X.X.
Subject: Motion transformation mechanisms and cams
SHV: 22h30 (Lectures 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

This course is a complement to the two subjects "Mechanical Construction" and "Mechanism Theory" taught in the third year of the Mechanical Construction degree. This course focuses on motion transformation mechanisms in general, and cam mechanisms in particular, as well as indexers and slide mechanisms. Given their importance and role in several industrial machines, special attention is given to cam mechanisms. The aim of the course is to deepen knowledge in the field of machine elements, as well as to introduce kinematic and dynamic calculations, enabling learners to acquire a basis for mastering, designing and synthesizing these mechanisms.

Recommended prior knowledge :

Industrial drawing, Rational mechanics, Theory of mechanisms, Mechanical construction, and Strength of materials.

Content of the course :

Chapter 1: Review of Mechanism Theory (3 weeks)

Different types of mechanical connections between solids.

Kinematic chains.

Static analysis of mechanisms.

Kinematic analysis of mechanisms.

Chapter 2: Technology of Slider-Crank Mechanisms (3 weeks)

Main slider-crank mechanisms.

Definitions of elements in a slider-crank mechanism.

Assessment method

Chapter 3: Kinematic Analysis and Synthesis of Cam Mechanisms (6 weeks)

Classification of cams.

Classification of followers.

Different follower motion laws.

Kinematic analysis of a cam mechanism.

Determination of the minimum cam radius.

Geometric characteristics of cams.

Construction of cams and followers.

Determination of the cam profile.

Analytical methods of analysis.

Cam manufacturing.

Assessment method :

Exam : 100%

Bibliographical references

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

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

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

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

Semester :x
Course unit : DTU xx
Subject : Industrial maintenance
SHV : 22h30 (Lectures : 1h30)
Cridits : 1
Coefficient : 1

Teaching objectives :

- Plan, estimate, direct, or carry out the installation, commissioning, troubleshooting, modification, and repair of equipment, tools, and machines;
- Design, implement, and manage preventive maintenance methods and processes;
- Organize and carry out modification or improvement of machines and production systems.

Recommended prior knowledge :

Basic concepts in industrial maintenance.

Content of the course:

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: Maintenance organization (1 week)

Place of maintenance in the general structure - Internal organization of maintenance - Human resources - Material resources.

Chapter 3: Maintenance methods and techniques (2 weeks)

Generalities - Maintenance methods (corrective, systematic preventive and conditional preventive) - Maintenance operations - Related maintenance activities.

Chapter 4: Availability and FMD concepts (4 weeks)

Reliability - Maintainability - Availability - FMD concepts - 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 week)

Purpose of documentation - Machine file.

Chapter 6: Maintenance costs (3 weeks)

Composition of costs - Cost analysis and ABC method - Optimal preventive maintenance - Example of calculation of MTBF - Replacement optimization using probability models - Choice between maintenance and replacement - Economic service life - Disposal of equipment.

Chapter 7: CMMS (2 weeks)

Assessment method :

Exam : 100%.

Bibliographical references :

1- *Jean-Claude Francastel, Ingénierie de la maintenance : De la conception à l'exploitation d'un bien, Editeur(s) : Dunod, L'Usine Nouvelle, Collection : Technique et ingénierie - Gestion industrielle, 2009.*
2- *François Castellazzi, Yves Gangloff, Denis Cogniel, Maintenance industrielle : Maintenance des équipements industriels, Editions : Cateilla, 2006.*
3- *Pascal Denis, Pierre Boyé, André Bianciotto, Guide de la maintenance industrielle, Editions : Delagrave, 2008.*
4- *Serge Tourneur, La maintenance corrective dans les équipements et installations électriques : Dépannage et mesurage, Editions : Cateilla, 2007.*
5- *Jean-Marie Auberville, Maintenance Industrielle De L'Entretien De Base A L'Optimisation De La Surete, Editions : Ellipse.*
6- *Sylvie Gaudeau, Hassan Houraji, Jean-Claude Morin, Julien Rey, Maintenance des équipements industriels. Tome 1 : Du composant au système. Editions : Hachette.*