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

ACADEMIC MASTER HARMONIZE

National program

2022 update

Domain	Sector	Speciality

Science And Technologies	***Electrical engineering***	***Electric machine***

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National Educational Committee for the field of Science and Technology

ماستر أكاديمية

تحديث2022

الميدان	الفرع	التخصص
علوم و تكنولوجيا	كهروتقني	ماكنات كهربائية

I–Master’s identity sheet

Access conditions

(Indicate the license specialties which can give access to the Master)

Sector	Harmonized Master	Access licenses to the master's degree	Ranking according to license compatibility	Coefficient assigned to the license
Electrical engineering	Electric machine	Electrical engineering	**1**	**1.00**
		Electromechanics	**2**	**0.80**
		Industrial maintenance	**2**	**0.80**
		Electronic	**3**	**0.70**
		Automatic	**3**	**0.70**
		Other licenses in the ST domain	**5**	**0.60**

II – Half-yearly teaching organization sheets of the specialty

Semester 1 Master:MachineryElectric

Teaching unit	Modules	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Evaluation mode	
	Titled			**Course**	**T.D.**	**TP**			**Continuous monitoring**	**Exam**
Fundamental EU Code: UEF 1.1.1 Credits: 10 Coefficients: 5	Electric energy transmission and distribution networks	4	2	1h30	1h30		45:00	55:00	40%	60%
	Advanced power electronics	4	2	1h30	1h30		45:00	55:00	40%	60%
	µ-processors and µ-controllers	2	1	1h30			10:30	27:30		100%
Fundamental EU Code: UEF 1.1.2 Credits: 8 Coefficients: 4	In-depth electrical machines	4	2	1h30	1h30		45:00	55:00	40%	60%
	Applied numerical methods and optimization	4	2	1h30	1h30		45:00	55:00	40%	60%
Methodological EU Code: UEM 1.1 Credits: 9 Coefficients: 5	TP: - µ-processors and µ-controllers	1	1			1h00	3:00	10:00	100%	
	TP: - Electric energy transport and distribution networks	2	1			1h30	10:30.	27:30	100%	
	TP: - Advanced power electronics	2	1			1h30	10:30	27:30	100%	
	TP: Applied numerical methods and optimization	2	1			1h30	10:30	27:30	100%	
	TP: - in-depth electrical machines	2	1			1h30	10:30	27:30	100%	
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	Technical English and terminology	1	1	1h30			10:30	02:30		100%

Code: UET 1.1 Credits: 1 Coefficients: 1										
Total semester 1		**30**	**17**	**12:00**	**6:00**	**7:00**	**375h00**	**375h00**		

Semester 2 Master: Electrical Machines

Teaching unit	Modules Titled	Credits	Coefficient	Weekly hourly volume **Course**	 **T.D.**	 **TP**	Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Evaluation mode **Continuous monitoring**	 **Exam**
Fundamental EU Code: UEF 1.2.1 Credits: 8 Coefficients: 4	Modeling of electrical machines	4	2	1h30	1h30		45h0	55:00	40%	60%
	Magnetic field in electrical machines	4	2	1h30	1h30		45:00	55:00	40%	60%
Fundamental EU Code: UEF 1.2.2 Credits: 10 Coefficients: 5	Sampled controls and digital regulation	4	2	1h30	1h30		45:00	55:00	40%	60%
	Construction of electrical machines	4	2	1h30	1h30		45:00	55:00	40%	60%
	Materials in electrical engineering and high voltage technology	2	1	1h30			10:30 p.m.	27:30		100%
Methodological EU Code: UEM 1.2 Credits: 9	TP: -Modeling of electrical machines	2	1			1h30	10:30	27:30	100%	
	TP Sampled controls and digital regulation	2	1			1h30	10:30	27:30	100%	

Coefficients: 5	TP Magnetic field in electrical machines	1	1			1h00	3:00	10:00	100%	
	Machine-converter association	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**	**1:30**	**6:00**	**5:30**	**375h00**	**375h00**		

Semester 3 Master: Electrical Machines

Teaching unit	Materials Titled	Credits	Coefficient	Weekly hourly volume **Course**	 **T.D.**	 **TP**	Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Evaluation mode Continuous monitoring	 Exam
Fundamental EU Code: UEF 2.1.1 Credits: 10 Coefficients: 5	Special electrical machines	4	2	1h30	1h30		45:00	55:00	40%	60%
	Transient regimes of electrical machines	4	2	1h30	1h30		45:00	55:00	40%	60%
	Computer-aided design of electrical machines	2	1	1h30			10:30	27:30		100%
Fundamental EU Code: UEF 2.1.2 Credits: 8 Coefficients: 4	Identification and diagnosis of electrical machines	2	1	1h30			10:30	27:30		100%

	Heating and cooling of electromechanical actuators	2	1	1h30			10:30	27:30		100%
	Control of electrical machines	4	2	1h30	1h30		45:00	55:00	40%	60%
Methodological EU Code: UEM 2.1 Credits: 9 Coefficients: 5	TP: - Special electrical machines	2	1			1h30	10:30	27:30	100%	
	TP: - Transient regimes of electrical machines	2	1			1h30	10:30	27:30	100%	
	Practical work: - Identification and diagnosis of electrical machines	2	1			1h30	10:30	27:30	100%	
	TP: Computer-aided design of electrical machines	1	1			1h00	3:00	10:00	100%	
	TPControl of electrical machines	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**	**1:30**	**4:30**	**7:00**	**375h00**	**375h00**		

Discovery Unit (S1, S2 and S3)

1- Centralized and decentralized production of electrical energy
2- Erenewable energies
3- Quality of electrical energy
4- Maintenance and operational safety
5- Industrial data
6- Implementation of real-time digital control
7- Electrical engineering materials and their applications
8- Techniquesof the'artificial intelligence
9- Standards and legislation in Electrotechnics
10- Industrial security and authorization
11- Industrial Ecology and Sustainable Development
12- Trams
13- Technical drawing
14- Electrical machines in dynamic mode

Semester 4

Internship in a company or in a research laboratory culminating in a dissertation and a defense.

	VHS	coefficient	Credits
Personal work	550	09	18
Internship in a company or 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 of the S1 semester

Semester: 1
Fundamental EU Code: UEF 1.1.1
Matter:Electric energy transmission and distribution networks
VHS: 45h (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The objective of this course can be divided into two: on the one hand the broadening of the knowledge acquired during the 'Electric Networks' course in License, and on the other hand introducing the necessary knowledge on the management and operation of electrical networks.

Recommended prior knowledge:

Fundamental laws of electrical engineering (Ohm's law, Kirchhoff's laws, etc.), Analysis of alternating current electrical circuits, complex calculation. Modeling of electrical lines (Bachelor's Electrical Networks Course).

Material content:

Chapter 1. Architectures of electrical substations (2 weeks)
Overall architecture of the electrical network, equipment and architecture of substations (bar-coupled substations, circuit breaker-coupled substations), topologies of energy transport and distribution networks.
Chapter 2. Organization of electric energy transportation
2.1. Power transmission lines (3 weeks)
Calculation of transmission lines: Choice of conductor section, insulation, mechanical calculation of lines, Operation of transmission lines in steady state. Operation of transmission lines in transitional regime. Direct current (HVDC) energy transport.
2.2. Distribution networks (2 weeks)
Introduction to electrical power distribution, primary distribution, secondary distribution, distribution transformers, reactive energy compensation in distribution networks, distribution reliability.
Chapter 3. Operation of MV and LV electricity networks(3 weeks)
Protection of HT/MV substations against overcurrents and overvoltages). Models of electrical network elements. Voltage adjustment, Voltage adjustment devices, - Control of reactive power on an electrical network
Chapter 4. Neutral diets (2 weeks)
Neutral regimes (insulated, earthed, impedant), artificial neutral.
Chapter 5. Adjusting the tension (3 weeks)
Voltage drop in electrical networks, voltage adjustment method (automatic adjustment of the voltage at the generator terminals, AVR, reactive energy compensation by conventional and modern means, voltage adjustment by autotransformer), introduction to the voltage stability.

Evaluation method:

Continuous monitoring: 40%; Examination: 60%.

Bibliographic references:

1. *F. Kiessling et al, 'Overhead Power Lines, Planning, design, construction'. Springer, 2003.*
2. *T. Gonen et al, 'Power distribution', book chapter in Electrical Engineering Handbook. Elsevier Academic Press, London, 2004.*
3. *E. Acha and VG Agelidis, 'Power Electronic Control in Power Systems', Newns, London 2002.*
4. *TuranGönen: Electric power distribution system engineering. McGraw-Hill, 1986*
5. *TuränGonen: Electric power transmission system engineering. Analysis and Design. John Wiley & Sons, 1988*

Semester: 1
Fundamental EU Code: UEF 1.1.1
Matter:Advanced power electronics
VHS: 45h (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

To provide the electrical circuit concepts behind the different modes of operation of inverters to enable the deep understanding of their operation
To equip with the necessary skills to obtain the criteria for the design of power converters for UPS, Drives etc.,
Ability to analyze and understand the different modes of operation of different power converter configurations.
Ability to design different single-phase and three-phase inverters

Recommended prior knowledge:

Power components, basic power electronics,

Material content:

Chapter 1: Methods for modeling and simulation of power semiconductors
Idealized characteristic of different types of semiconductors, logical equations of semiconductors, simulation methods of static converters (2 weeks)
Chapter 2: Switching mechanisms in static converters Natural switching principle, forced switching principle, calculation of switching losses.
(3 weeks)
Chapter 3: Design methods for static converters with natural switching
Switching rules, definition of the switching cell, different types of sources, power exchange rules, direct and indirect converters example: study of a cyclo converter. (2 weeks)
Chapter 4: Design methods for forced switching static converters
- PWM inverter
- Sinusoidal absorption rectifier
- PWM dimmer
- Switching power supplies (3 weeks)

Chapter 5: Multi-level inverter (3 weeks)
Multi-level concept, topologies, Comparison of multi-level inverters. PWM control techniques for PWM inverter - single phase and three phase impedance source.
Chapter 6: Energy quality of static converters (2 weeks)
- Harmonic pollution due to static converters (Case study: rectifier, dimmer).
- Study of harmonics in voltage inverters.
- Introduction to depollution techniques

Evaluation method:

Continuous monitoring: 40%; Examination: 60%.

Bibliographic references:

1. *Power electronics, from switching cells to industrial applications. Courses and exercises, A. Cunière, G. Feld, M. Lavabre, Casteilla editions, 544 p. 2012.*
2. *-Technical encyclopedia "Engineering techniques", treatise on Electrical Engineering, vol. D4 items D3000 to D3300.*

Semester: 1
Fundamental EU Code: UEF 1.1.1
Matter:µ-processors and µ-controllers
VHS: 10:30 p.m. (Class: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives

Know the structure of a microprocessor and its usefulness. Differentiate between microprocessor, microcontroller and calculator. Know the organization of a memory. Know assembly programming. Understand the use of I/O interfaces and interrupts. Use of the micro controller (programming, system control).

Recommended prior knowledge

Combinatorial and sequential logic, industrial automation

Content of the material:

Chapter 1: Architecture and operation of a microprocessor(2 weeks)
Structure of a computer, Circulation of information in a computer, Hardware description of a microprocessor, Operation of a microprocessor, memories
Example: The Intel 8086 microprocessor
Chapter 2: Assembler programming(2 weeks)
General, The instruction set, Programming method.
Chapter 3: Interrupts and I/O interfaces(3 weeks)
Definition of an interrupt, Support for an interrupt by the microprocessor, Addressing of interrupt subroutines,
I/O port addressing, I/O port management
Chapter 4: Architecture and Operation of a Microcontroller(3 weeks)
Hardware description of a µ-controller and its operation. Programming the µ-controller
Example: The PIC µ-controller
Chapter 5: Applications of Microprocessors and Microcontrollers(4 weeks)
LCD Interface - Keypad Interface - Port Signal Generation Gate for Converters - Motor - Control - Control of DC/AC Devices - Frequency Measurement - Data Acquisition System

Evaluation method:

100% review.

Bibliographic references:

1. M. Tischer and B. Jennrich. The PC bible – System programming. Micro Application, Paris, 1997.
2. R. Tourki. The PC computer – Architecture and programming – Courses and exercises. University Publication Center, Tunis, 2002.
3. H. Schakel. Programming in assembler on PC. Micro Application, Paris, 1995.
4. E. Pissaloux. Practice of the I80x86 assembler – Courses and exercises. Hermès, Paris, 1994
5. R Zaks and A. Wolfe. From component to system – Introduction to microprocessors. Sybex, Paris, 1988.

Semester: 1
Fundamental EU Code: UEF 1.1.2
Matter:In-depth electrical machines
VHS: 45h (Class: 1h30, tutorial 1h30)
Credits: 4
Coefficient: 2

Teaching objectives

At the end of this course, the student will be able to establish the general electromechanical energy conversion equations applied to synchronous, asynchronous and direct current machines and will be able to determine their characteristics in static or variable regimes. This makes it possible in particular to take into account the association of machines with static converters.

Recommended prior knowledge

-Three-phase electrical circuits, alternating current, power. Magnetic circuits, Single-phase and three-phase transformers, Direct and alternating current electrical machines (motor and generator operation).

Content of the material:

Chapter 1: General principles (3 weeks)

Principle of electromechanical energy conversion. Principle of stator/rotor coupling: the primitive machine. Windings of electrical machines.calculation of magnetomotive forces. Mechanical equation;

Chapter 2: Synchronous machines (4 weeks) Generalities and equations of the synchronous machine with smooth poles. Study of the operation of the synchronous machine. Ddifferent excitation systems.Induce reactions. Elements on the salient pole synchronous machine without and with shock absorbers. Potier diagrams, two reactance diagrams and Blondel diagrams. Elements on permanent magnet machines. Alternators andParallel coupling.Synchronous motors, starting…

Chapter 3: Asynchronous machines (4 weeks) General. Equation. Equivalent schemes. Torque of the asynchronous machine. Characteristics and diagram of the asynchronous machine. Engine/generator operation, starting, braking. Deep slot and double cage motors, Single-phase asynchronous motors.

Chapter 4: Direct current machines (4 weeks)
Structure of direct current machines. Equations of DC machines. Modes for starting, braking and speed adjustment of DC motors.Switching phenomena. Saturation and armature reaction. Auxiliary switching poles. Engine/generator operation.

Evaluation method:

Continuous monitoring: 40%; Examination: 60%.

Bibliographic references:

1. *J.-P. Caron, JP Hautier: Modeling and control of the asynchronous machine, Technip, 1995.*
2. *G. Grellet, G. Clerc: Electric actuators, Principles, Models, Controls, Eyrolles, 1996.*

Semester: 1
Fundamental EU Code: UEF 1.1.2

Matter:In-depth electrical machines
VHS: 45h (Class: 1h30, tutorial 1h30)
Credits: 4
Coefficient: 2

Teaching objectives

At the end of this course, the student will be able to establish the general electromechanical energy conversion equations applied to synchronous, asynchronous and direct current machines and will be able to determine their characteristics in static or variable regimes. This makes it possible in particular to take into account the association of machines with static converters.

Recommended prior knowledge

Three-phase alternating current electrical circuits. Magnetic circuits. Single-phase and three-phase transformers.

Content of the material:

Chapter 1: General principles **(3 weeks)**

Principle of electromechanical energy conversion. Principle of stator/rotor coupling: the primitive machine. Windings of electrical machines.calculation of magnetomotive forces. Mechanical equation;

Chapter 2: Synchronous machines **(4 weeks)**Generalities and equations of the synchronous machine with smooth poles. Study of the operation of the synchronous machine. Ddifferent excitation systems.Induce reactions. Elements on the salient pole synchronous machine without and with shock absorbers. Potier diagrams, two reactance diagrams and Blondel diagrams. Elements on permanent magnet machines. Alternators andParallel coupling.Synchronous motors, starting…

Chapter 3: Asynchronous machines **(4 weeks)**General. Equation. Equivalent schemes. Torque of the asynchronous machine. Characteristics and diagram of the asynchronous machine. Engine/generator operation, starting, braking. Deep slot and double cage motors, Single-phase asynchronous motors.

Chapter 4: Direct current machines **(4 weeks)**

Structure of direct current machines. Equations of DC machines. Modes for starting, braking and speed adjustment of DC motors.Switching phenomena. Saturation and armature reaction. Auxiliary switching poles. Engine/generator operation.

Evaluation method:

Continuous monitoring: 40%; Examination: 60%.

Bibliographic references:

1. *J.-P. Caron, JP Hautier: Modeling and control of the asynchronous machine, Technip, 1995.*
2. *G. Grellet, G. Clerc: Electric actuators, Principles, Models, Controls, Eyrolles, 1996*.
3. J. Lesenne, F. Notelet, G. Séguier: Introduction to in-depth electrical engineering, Technique and Documentation, 1981.
4. Paul C. Krause, Oleg Wasyzczuk, Scott S, Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley, Second Edition, 2010.
   PS Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 2008
5. AE, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, "Electric Machinery", Tata McGraw Hill, 5th Edition, 1992

Semester: 1
Fundamental EU Code: UEF 1.1.2

Matter:**Applied numerical methods and optimization**
VHS: 45h (Class: 1h30, tutorial 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The objective of this course is to present the tools necessary for numerical analysis and optimization, with or without constraints, of physical systems, in the field ofengineering.

Recommended prior knowledge:

Mathematics, programming, mastery of the MATLAB environment.

Material content:

Chapter I: Reminders on some numerical methods (3 weeks)

- Resolution of nonlinear systems of equations by iterative methods.
- Digital integration and differentiation.
- Methods for solving ordinary differential equations (ODE): Euler methods; Runge-Kutta methods; Adams method.
- System resolutionEDO.

Chapter II: Partial Differential Equations (PDE) (6 weeks)

- Introduction and classifications of partial differential problems and boundary conditions;
- Methods for solving PDEs: Finite difference method (FDM); Finite Volume Method (FVM); Finite element method (FEM).

Chapter III: Optimization techniques (6 weeks)

- Definition and formulation of aoptimization problems.
- Single and multiple optimization with or without constraints.
- Optimization algorithms without constraints (deterministic methods, stochastic methods).
- Treatment of constraints (Transformation methods, Direct methods).

Evaluation method:

Continuous monitoring: 40%; Examination: 60%.

Bibliographic references:

1. *G.Allaire, Numerical Analysis and Optimization, Edition of the polytechnic school, 2012*
2. *SS Rao, 'Optimization – Theory and Applications', Wiley-Eastern Limited, 1984*
3. *A. Fortin, Numerical analysis for engineers, Presses Internationales Polytechnique, 2011.*
4. *J. Bastien, JN Martin, Introduction to numerical analysis: Application under Matlab, Dunod, 2003.*
5. *A. Quarteroni, F. Saleri, P. Gervasio, Scientific computing, Springer, 2008.*
6. *TA Miloud, Numerical methods: Finite difference method, integral and variational method, University Publications Office, 2013.*
7. *JP Pelletier, Numerical techniques applied to scientific computing, Masson, 1982.*
8. *F. Jedrzejewski, Introduction to numerical methods, springer, 2001.*
9. *P. Faurre, Numerical analysis, optimization notes, Ecole polytechnique, 1988.*
10. *Fort. Numerical analysis for engineers, international polytechnic presses, 2011.*
11. *J. Bastien, JN Martin. Introduction to numerical analysis: Application in Matlab, Dunod, 2003.*
12. *Quarteroni, F. Saleri, P. Gervasio. Scientific computing, Springer, 2008.*

Semester 1

Methodological EUCode: UEM 1.1
Matter:TP - µ-processors and µ-controllers
VHS: 15h (Class: 1h)
Credits: 1
Coefficient: 1

Teaching objectives

Know assembly programming. Know the principle and execution steps of each instruction. Understand the use of I/O interfaces and interrupts. Use of the micro controller (programming, system control).

Recommended prior knowledge

Combinatorial and sequential logic, industrial automation, algorithms.

Content of the subject

TP1: Getting started with a programming environment on a µ-processor (2 weeks)
TP2: Programming arithmetic and logic operations in a µ-processor
(2 weeks)
TP3: Use of video memory in a µ-processor (2 weeks)
TP4: Management of µ-processor memory. (2 weeks)
TP5: Control of a stepper motor by a µ-processor (2 weeks)
TP6: Screen management (1 week)
TP7: Programming the PIC µ-microcontroller (2 weeks)
TP8: Control of a stepper motor by a PIC µ-microcontroller (2 weeks)

Evaluation method:

Continuous control: 100%.

Bibliographic references:

1. R. Zaks and A. Wolfe. From component to system – Introduction to microprocessors. Sybex, Paris, 1988.
2. M. Tischer and B. Jennrich. The PC bible – System programming. Micro Application, Paris, 1997.
3. [3] R. Tourki. The PC computer – Architecture and programming – Courses and exercises. University Publication Center, Tunis, 2002.
4. H. Schakel. Programming in assembler on PC. Micro Application, Paris, 1995.
5. E. Pissaloux. Practice of the I80x86 assembler – Courses and exercises. Hermès, Paris, 1994

Semester: 1
Methodological EUCode: UEM 1.1
Matter:**TP Electrical energy transport and distribution networks**
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Allow the student to have all the necessary tools to manage, design and operate electro-energy systems and more particularly electrical networks

Recommended prior knowledge:

General information on electrical transmission and distribution networks

Material content:

TP No. 1: Voltage adjustment by synchronous motor
TP No. 2: Power distribution and calculation of voltage drops
TP No. 3: Voltage adjustment by reactive energy compensation
TP No. 4: Neutral regime
TP No. 5: Interconnected Networks

Evaluation method:

Continuous control: 100%.

Bibliographic references:

1. Sabonnadière, Jean Claude, Electric lines and networks, Vol. 1, Electric Power Lines, 2007.
2. Sabonnadière, Jean Claude, Electric lines and networks, Vol. 2, Methods for analyzing electrical networks, 2007.
3. Lasne, Luc, Exercises and problems in electrical engineering: basic notions, networks and electrical machines, 2011.
4. J. Grainger, Power system analysis, McGraw Hill, 2003
5. WD Stevenson, Elements of Power System Analysis, McGraw Hill, 1998.

Semester: 1
Methodological EUCode: UEM 1.1
Matter:**Advanced power electronics TP**
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Allow the studentto understand the operating principles of new power electronics converter structures.

Recommended prior knowledge:

Basic principle of power electronics

Material content:

TP1: New converter structures
TP2: Improvement of the power factor;
TP3: Elimination of harmonics
TP4: Static reactive power compensators

Evaluation method:

Continuous control: 100%;

Bibliographic references:

1. GuySéguier and Francis Labrique, “Power electronics converters – volumes 1 to 4”
2. Ed. Lavoisier Tec and very rich documentation available in the library. - Website: “Courses and Documentation”
3. Valérie Léger, Alain Jameau Energy conversion, electrotechnics, power electronics. Course summary, problems corrected", ,: ELLIPSES MARKETING

Semester: 1
Methodological EUCode: UEM 1.1
Matter:TPApplied numerical methods and optimization
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Program numerical solution methods and those associated with optimization problems.

Recommended prior knowledge:

Algorithmic and programming.

Material content:

- Initialization to the MATLAB environment (Introduction, Basic aspects, comments, vectors and matrices, M-Files or scripts, functions, loops and control, graphics, etc.). (01 week)

- Write a program for:
  - Calculate the integral by the following methods: Trapezoid, Simpson and general; (01 week)
  - Solve equations and systems of ordinary differential equations using the different Euler, Runge-Kutta methods of order 2 and 4 (02 weeks)
  - Solve systems of linear and non-linear equations: Jacobi; Gauss-Seidel; Newton-Raphson; (01 week)
  - Solve PDEs using MDF and MEF for the three (03) types of equations (Elliptic, parabolic and elliptic); (06 weeks)
  - Minimize a function with several variables without constraints (02 weeks)
  - Minimize a multivariable function with constraints (inequalities and equalities). (02 weeks)

Evaluation method: Continuous control: 100%;

Bibliographic references:

1. G.Allaire, Numerical Analysis and Optimization, Edition of the polytechnic school, 2012
2. Computational methods in Optimization, Polak, Academic Press, 1971.
3. Optimization Theory with applications, Pierre DA, Wiley Publications, 1969.
4. Taha, HA, Operations Research: An Introduction, Seventh Edition, Pearson Education Edition, Asia, New Delhi, 2002.
5. SS Rao, "Optimization – Theory and Applications", Wiley-Eastern Limited, 1984.

Semester: 1

Methodological EUCode: UEM 1.1
Matter:**TPIn-depth electrical machines**
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Recommended prior knowledge:

Good command of IT tools and MATLAB-SIMULINK software.

Material content:

1. Electromechanical characteristics of the asynchronous machine;
2. Circle diagram;
3. Asynchronous generator autonomous operation;
4. Coupling of an alternator to the network and its operation with the synchronous motor;
5. Determination of the parameters of a synchronous machine;

Evaluation method:

Continuous control: 100%

Bibliographic references:

1. *Th. Wildi, G. Sybille "electrotechnics", 2005.*
2. *J. Lesenne, F. Noielet, G. Seguier, "Introduction to in-depth electrical engineering" Univ. Lille. nineteen eighty one.*
3. *MRetif "Vector Control of asynchronous and synchronous machines" INSA, Pedg course. 2008.*
4. *R. Abdessemed "Modeling and simulation of electrical machines" ellipses,2011.*

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

<u>Noticed</u>:
It is possible for the specialty team to freely choose the discovery subjects offered or those offered in the basket according to the means, needs and interest of the training.

Semester: 1
Teaching unit: UET 1.1
Matter :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: Based on 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 semesters

Semester: 2
Fundamental EU Code: UEF 1.2.1
Matter: Modeling of electrical machines
VHS: 45h (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives

The main objective is to deepen students' knowledge of the different mathematical models dedicated to the study of the dynamic behavior of electrical machines.

Recommended prior knowledge

Basic concepts of electrical machines.

Content of the material:

I: Physical and mathematical processesof study (02 weeks).

- Reminders about magnetically coupled circuits
- electromechanical energy conversion
- Machine inductance
- Symmetric and relative components

II: Theory of the generalized electric machine (04 weeks).

- Idealized electric machine
- Idealized electric machine in the natural landmark
- Three-phase model of the generalized electric machine
- generalized electric machine in complex form
- Switching from a three-phase system to a two-phase system and vice versa
- Equation of motion of the electric machine

III: Modeling of direct current electrical machines (03 weeks).

- Model of the DC machine on the d, q axes
- Application of generalized theory to various modes of excitation
- Generator operation
- Motor operation

IV: Modeling of asynchronous machines(03 weeks).

- Linear three-phase asynchronous machine model
- Model of the saturated three-phase asynchronous machine
- Model of single-phase asynchronous motors with permanent capacitor

V: Modeling of synchronous machines (03 weeks).

- Modeling of synchronous motors without and with dampers
- Modeling of synchronous generators without dampers

Evaluation method:*40%, exam: 60%*

Bibliographic References

1.R. Abdessemed, "Modeling and simulation of electrical machines", Ellipses,Collection, 2011.

2.M. Jufer, "Electric drives: Design methodology", Hermès, Lavoisier,2010.

3.G. Guihéneuf, "Electric motors explained to electronic engineers, Achievements: starting, variation of speed, braking", Publitronic, Elektor, 2014.

4.P. Mayé, "Industrial electric motors, Bachelor, Master, engineering schools", Dunod,Collection: Advanced Sciences,2011.

5.S. Smigel,"Modeling and control of three-phase motors. Vector control of synchronous motors", 2000.

6.J. Bonal, G. Séguier, "Electric drives at variable speeds". Flight. 2, Vol. 3.

Semester: 2
Fundamental EU Code: UEF 1.2.1
Matter:Magnetic field in electrical machines
VHS: 45h (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

At the end of this course, the student will be able to determine, via a two-dimensional model, the characteristics of conventional electrical machines by solving the equations of the electromagnetic field: analytically, by using the method of separate variables, for geometries simple and numerically, by the finite element method, the finite difference method or the boundary integral method, for complex geometries,

Recommended prior knowledge

Basic electromagnetism. Basic electrical engineering: Direct and alternating current electrical machines (motor and generator operation). Magnetic materials. Electric and magnetic circuits. Basic mathematics: resolution of partial differential equations, analysis and differential geometry, matrix calculation. Numerical analysis: Finite difference and finite element method. Computer programming.

Content of the material:

CHAPTER I: Basic Electromagnetism Supplements. (02 Weeks)

I.1. Electrostatics and magnetostatics reminders
I.2. Electromagnetic induction reminders.
I.3. Maxwell's equations: differential and integral forms (Gauss' theorems, Ampere's theorem and Faraday's law).
I.4. Interface relationships, boundary conditions, and gauge conditions.
I.5. Constitutive laws of media (electric, magnetic and dielectric).

CHAPTER II: Principles of electromechanical energy conversion. (02 weeks)
II.1. The basics of electromechanical energy conversion.
II.2. Poynting vector, electrostatic energy, magnetic energy/co-energy, electrical losses.
II.3. Methods for calculating magnetic force and electromagnetic torque:
Approaches based on energies/co-energy and on the Maxwell tensor

CHAPTER III: Potential formulations of electromagnetic models. (04 weeks)
III.1. Electrostatic formulations in scalar potential or electric vector.
III.2. Magnetostatic formulations in magnetic, vector and scalar potentials
III.3. Electrokinetic formulation.
III.4. Magnetodynamic formulations in magnetic vector potential A, electric scalar potential V, electric vector potential T, magnetic scalar potential Ω.

CHAPTER IV: Methods for solving partial differential equations (PDE) (04 weeks)

IV.1. Approaches to solving (EDP) in Electrical Engineering.
IV.2. Finite Element (FE) formulation of static field models:
IV.3. FE formulation of dynamic models with induced currents in magnetic vector potential

CHAPTER V: Application to electrical machines (03 weeks)

Evaluation method: Continuous assessment 40%, exam: 60%

Bibliographic references:

1. E. Durand: “Magnetostatics. », Masson, Paris, 1968.

2. G. Fournet: “Electromagnetism from local equations”, Masson, Paris, 1985.

3. FORSYTHE and WASOW: “Finite difference methods for partial differential equations”, John Wiley and Sons.

4.Peter P. Silvester, MVK Chari: “Finite Elements in Electrical and Magnetic Field Problems.” John Wiley & Sons Inc, 1980

5.Peter P. Silvester, Ronald L. Ferrari: “Finite Elements for Electrical Engineer.” , 3ed, Cambridge University Press, 1996.

6. Nicola Bianchi:”Electrical Machine Analysis using Finite Elements.” ,Taylor & Francis Group,CRC Press2005.

7. Sheppard J. Salon:”Finite Element Analysis of Electrical Machines.” ,Springer Science+Business Media New York, 1996.

Semester: 2
Fundamental EU Code: UEF 1.2.2
Matter:Construction of electrical machines
VHS: 45 hours (Class: 1h30, tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The student will be able to calculate and size an electrical machine according to the requirements of precise specifications.

Recommended prior knowledge:

Electrical machines and programming software.

Content of the material:

Chapter I: Materials used in electrical machines (01 Week)

- Magnetic materials;
- Conductive materials;
- Insulating materials;
- Winding wires;
- Construction materials.

Chapter II: Magnetic circuit. Different settings. Losses (02 Weeks)

- Magnetic circuit calculation;
- Calculation of the different parameters of electrical machines;
- Calculation of losses and returns.

Chapter III: Armature windings (03 Weeks)

Winding types of alternating current machines; Coil insulation; Utilization coefficient; Notch filling coefficient; Winding coefficient; single-layer and double-layer windings; Winding types of direct current machines.

Chapter IV: Calculation of electrical machines

IV.1 - Asynchronous machines**(03 Weeks)**

Calculation of a cage and wound rotor machine, choice of winding, determination of parameters and losses, characteristics

IV.2 - Synchronous machines:**(03 Weeks)**

Calculation of a machine with smooth poles and salient poles with shock absorbers, choice of winding, determination of parameters and losses and characteristics.

IV.3 - Direct current machines**(03 Weeks)**

Calculation, choice of material, choice of winding, determination of losses and parameters and characteristics

Evaluation method: Continuous monitoring40%, exam: 60%

Bibliographic references:

1.M. Kostenko, L. Piotrovsky, Electrical machines, Volumes I and II, Editions Mir, Moscow, 1979.

2.J.Pyrhönen, T.JokinenetV.Hrabovcovà “Design of rotating electrical Machines”, Wiley, 2008.

3. IP Kopilov “Calculation of electrical machines”, Energy Edition, Moscow, 1980.

Semester: 2
Fundamental EU Code: UEF 1.2.2
Matter:Materials in electrical engineering and high voltage technology
VHS: 10:30 p.m. (Class: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives

The objective of this module is the introduction of the main electrical and magnetic properties of materials. The student must be able to formulate the different parameters relating to the electrical and magnetic properties of materials and understand the related phenomena and mechanisms.

The teaching thus provided will allow the student to identify his area of specialty and to treat the materials which are the seat and support of electromagnetic phenomena with a relatively developed formalism.

Recommended prior knowledge

Basic notions of electricity, magnetism and the structure of matter.

Content of the material:

Chapter I:**Materialsdielectric(03 weeks).**

I.1. Definitions: Electric dipole, Dipole moment, Polarization vector.
I.2. Representation of a polarization state
I.3. Electrical Induction (generalization of Gauss's law)
I.4. Dielectric permittivity
I.5. Boundary conditions in a dielectric
I.6. Local field
I.7. Polarization Factor
I.8. Types of Polarization: Electronic polarization; Ionic polarization; Dipolar polarization (orientational) and interfacial polarization.
I.9. Clausuis–mossotti relationship
I.10. Permittivity of a homogeneous mixture
I.11. Electronic polarization in variable regime: Simplified model; Improved model;
I.12. Dipolar polarization in variable regime.
I.13. Study of conduction currents and displacement currents in a dielectric
I.14. Equivalent diagram of a dielectric in static regime
I.15. Transient currents in insulators: Absorption current; Resorption current.
I.16. Polarization Index
I.17. Equivalent diagram of a dielectric in variable regime
I.18. Dielectric losses
I.19. Dielectric dissipation factor
I.20. Effect of frequency on dielectric losses
I.21. Dielectric strength and breakdown mechanisms
I.22. Degradation of dielectric strength
I.23. Constraints encountered by the isolation function
- Mechanical, electrical, climatic and radiative constraints…

I.24. Method for choosing an insulator

Chapter II: Magnetic Materials**(04 weeks).**

II.1. Definitions: Magnetic moment, magnetic dipole, amperian currents;
II.2. Magnetization vector;
II.3. Magnetic vector potential;
II.4. Representation of a magnetization state;

II.5. Generalization of Ampère's law;
II.6. Permeability and magnetic susceptibility;
II.7. Nature of Materials: Orbital magnetic moment, spin magnetic moment;
II.8. Classification of magnetic materials:

- Diamagnetic materials;
- Paramagnetic materials;
- Ferromagnetic materials;
- Anti-ferromagnetic materials;
- Ferrimagnetic materials.

II.9. Magnetic domains:

- The origin of the domain structure

II.10. Magnetization curve;
II.11. Hysteresis cycle and its dependence on frequency and temperature;
II.12. Soft magnetic materials:

- Examples and characteristics;
- Losses by hysteresis and eddy currents.

II.12. Hard magnetic materials:

- Examples and characteristics.

II.13. Measurement of magnetic characteristics
II.14. Magnetic circuits
Chapter III: - Conductive Materials**(03 weeks).**
III.1. Definitions and Physical Properties
III.2. Poverview of different types of drivers
III.3. Modification of characteristics in relation to external phenomena (temperature,etc.).
- Semiconductor materials
III.4. Introduction of semiconductors.
III.5. Definition of semiconductors, types of semiconductors, pn junction and applications.
III.6. Change in characteristics compared toexternal phenomena (temperature,etc.).
Chapter IV: Superconductivity and superconducting materials**(02 weeks).**
IV.1. Definition of the superconducting state.
IV.2. BCS theory.
IV.3. Applications and integration of superconductors in electrical engineering.

Chapter V: High Voltage Techniques(03 weeks).
V.1. Source of high voltage: (General; Source of HT in continuous, alternating, and impulse)
V.2. HV metrology: (Measurement of alternating and continuous shock HV; Measurements of dielectric losses)
V.3. Element of electromagnetic compatibility: (General information on disturbed systems; Practical rules for protection against electric and magnetic fields)
V.4. Electric discharges: (Discharges in gases, in liquids, in solids; Protection against lightning; Corona effect)
V.5. Impact of HT on the environment

Evaluation method:continuous monitoring*40%, exam: 60%*

Bibliographic references:

1. P. Brissonneau: “Magnetism and Magnetic Materials for electrical engineering.”, Hermes, Paris, 1997.
2. R. BOX,J. Neirynck “Electrotechnical Materials”, Treatise on Electricity, vol. II, Presses polytechniques et universitaire romandes, Lausanne, 1989.

Semester: 2
Fundamental EU Code: UEF 1.2.2
Matter:Sampled servos and digital regulation
VHS: 45h (Class: 1h30, tutorial 1h30)
Credits: 4
Coefficient: 2

Teaching objectives

The main objective is to deepen students' knowledge of servo control and digital regulation techniques.

Recommended prior knowledge

Basics of enslavement.

Content of the material:

Chapter 1 :Modelizationsignals and systems sampled(03 weeks).

1.1 Introduction;
1.2 Fundamentals of signal sampling;
1.3 Examples of simple sampled signals;
1.4 Z-transform of sampled signals;
1.5 Transfer function in z;
1.6 Discrete-time Fourier transform;
1.7 Frequency behavior of the sampled systems;
1.8 Relations between continuous-time and discrete-time models.

Chapter 2:Stability and performance of sampled servo systems(05 weeks).

2.1 Equation of the sampled servos;
2.2 Stability of the sampled controls;
2.3 Continuous servo-controls controlled or corrected in discrete time;
2.4 Precision of sampled servos;
2.5 Dynamic performance of a sampled system.

Chapter 3:Fixing Slave Sampled Systems(04 weeks).

3.1 General principles;
3.2 Attempts at simple corrective actions;
3.3 Synthesis of a digital corrector by discretization of a continuous corrector;
3.4 Synthesis of a digital corrector by polynomial method.

Chapter 4:State representation of discrete-time systems(03 weeks).
4.1 General principle;
4.2 Resolution of state equations;
4.3 Controllability of a discrete-time system;
4.4 Observability of the state of a system;
4.5 Relationship between the state representation and the transfer function of a system;
4.6 Sampled control of a continuous time system;

Evaluation method: Continuous assessment 40%, exam: 60%

Bibliographic references:

1. P. Clerc. Continuous automatic, sampled: IUT Electrical Engineering-Industrial Computer Science, BTS, Electronics-Mechanics-Computer Science, Editions Masson (198p), 1997.

2.Ph. de Larminat, Automatic, Editions Hermes 2000.

3.P. Codron and S. Leballois, Automatic: continuous linear systems, Editons Dunod 1998.

4.Y. Granjon, Automatic: Linear, nonlinear, continuous-time, discrete-time systems, state representation, Editions Dunod, 2001.

5.K. Ogata, Modern control engineering, Fourth edition, Prentice Hall International Editions 2001.

6.B. Pradin, Course of Automatics. INSA Toulouse, 3rd year GII specialty.

7.M. Rivoire and J.-L. Ferrier, Cours d'Automatique, volume 2: servocontrol, regulation, analog control, Editions Eyrolles 1996.

8.Y. Thomas, “Signals and linear systems: corrected exercises”, Editions Masson 1993.

9.Y.Thomas. “Signals and linear systems”, Editions Masson 1994.

Semester 2
Methodological EUCode: UEM 1.2
Matter:**TP Modeling of electrical machines**
VHS: 10:30 p.m. (Class: 1 hour)
Credits: 2
Coefficient: 1

Teaching objectives
The main objective is to implement mathematical models of electrical machines with a view to digital simulation of their behavior.

Recommended prior knowledge
Electric machine. Computer programming.

Content of the material:
- Modeling and simulation of a DC motor with separate excitation;
- Modeling and simulation of a three-phase asynchronous motor;
- Modeling and simulation of a permanent magnet synchronous generator.

Evaluation method: Review: 100%

Bibliographic references:

TP brochure; Course notes ; Lab documentation.

Semester: 2
Methodological EUCode: UEM 1.2
Matter:TPSampled servos and digital regulation
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Know how to model and simulate discrete systems. Understand sampling and reconstruction. Verify the dynamic behavior of discrete systems. Simulate and implement digital PID, RST and status feedback regulators.

Recommended prior knowledge:

Know how to use simulation and programming software. Control of continuous linear systems.

Content of the material:

TP 1: Sampling and reconstitution (01 week)

TP 2: Sampled systems: temporal analysis and frequency analysis (02 weeks)

TP3: Control by digital PID regulator (04 weeks)

TP4: Digital RST command (04 weeks)

TP5: Digital control by status feedback (04 weeks)

Evaluation method:

Continuous control: 100%

Bibliographic references:

1. Sampled settings (T1 and T2), H. Buhler, PPR
2. Industrial regulation, E. Godoy, Dunod
3. Computer controlled systems, KJ Astrom and B. Wittenmark, Prentice Hall
4. Automatics of sampled systems, JM Retif, INSA

Semester: 2
Methodological EUCode: UEM 1.2
Matter:TP Magnetic field in electrical machines
VHS: 15h (TP: 1h)
Credits: 1
Coefficient: 1

Teaching objectives

Allow the student to become familiar with solving the electromagnetic field equations. Being able to implement calculation programs for analytical cases or even use codes in the case of numerical resolutions.

Recommended prior knowledge

Mathematical. Electric machine. Electromagnetic field theory. Numerical analysis. Computer programming.

Content of the material:

- Writing a computer program for the analytical resolution of simple cases of 1D and 2D partial differential equations. (03 weeks)
- Writing a program to calculate the field in a linear electrical machine (linear MSAP, Linear MAS, Linear reluctance machine etc.); (04 weeks)
- Use of finite element calculation software to determine the global quantities of a given electrical machine from local electromagnetic quantities. MSAP, MAS, MRV: linear/nonlinear static regimes. (08 weeks)

Evaluation method:100% continuous control

Reference :

1. E. Durand: “Magnetostatics. », Masson, Paris, 1968.
2. G. Fournet: “Electromagnetism from local equations”, Masson, Paris, 1985.
3. Forsythe and Wasow: “Finite difference methods for partial differential equations”, John Wiley and Sons.
4.Peter P. Silvester, MVK Chari: “Finite Elements in Electrical and Magnetic Field Problems.” John Wiley & Sons Inc, 1980
5.Peter P. Silvester, Ronald L. Ferrari: “Finite Elements for Electrical Engineer.” , 3ed, Cambridge University Press, 1996.
6. JP Louis “Modeling of electrical machines with a view to their control”, Hermes – Sciences, Lavoisier, Paris 2004.

Semester: 2
Methodological EUCode: UEM 1.2
Matter:: Machine-converter association
VHS: 45h (Class 1h30, practical work: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Mastery of the different possibilities of association between electrical machines and static converters.

Recommended prior knowledge:

Electrical machines, machine modeling, power electronics, notions of mechanics, control and regulation.

Content of the material:

Chapter 1: Direct current converter-motor (03 weeks)

1.1. MCC – Three-phase rectifier**(**Mode of operation and electromechanical equations, Determination of smoothing inductance, Insertion of armature voltage, bidirectional converter with and without circulating current, inversion of excitation field).
1.2. MCC- Chopper**(**Adjustment of rotation speed, Operating speed with independent motor, Operating speed with series motor, Regenerative braking technique, Rheostatic braking technique, Operation in the 4 quadrants, Chopper – series traction motor association).

Chapter 2: Asynchronous machine – Static converters (05 weeks)

2.1. Interest in variable speed;
2.2. Speed variation processes (by action on voltage, variation of rotor resistance by chopper, hyposynchronous cascade, braking modes, Operation in the 4 quadrants);
2.3. MAS – Three-phase dimmer (Soft start and speed variation,Reversal of the direction of rotation, Industrial application).
2.4. Speed variation of MAS by inverter (Current supply, voltage supply, introduction to multi-level structures)
2.5 Industrial frequency variators (AC/DC/AC –MAS converter association)

Chapter 3: Synchronous machine - static converters (03 weeks)

3.1. Starting the synchronous motor (Current inverter – MS, Voltage inverter – MS
Different types of controls, operation at low speeds and starting aid circuits)
3.2. Autopilot of the Synchronous Motor

Chapter 4: Special machines – Static converters (02 weeks)
4.1. Voltage inverter – Brushless motor;
4.2. Resolver sensor;
4.3. Power supply for stepper motors.

Chapter 5: Converter-machine interactions (02 weeks)

Study the effects of harmonics generated by the CS on the machine (additional losses, torque pulsations, etc.).

Practical work program:

- Simulation of the direct current machine associated with a chopper;
- Simulation of the association: voltage inverter with PWM sine triangle and vector - synchronous machine;
- Simulation of the inverter-asynchronous machine association.

Evaluation method:

Continuous monitoring40%; Exam: 60%.

Semester: 2
Teaching unit: UED 1.2
Matter :Subject 3 of your choice
VHS: 10:30 p.m. (class: 1h30)
Credits: 1
Coefficient: 1

Semester: 2
Teaching unit: UED 1.2
Matter :Subject 4 to choose from
VHS: 10:30 p.m. (class: 1h30)
Credits: 1
Coefficient: 1

<u>Noticed</u>:
It is possible for the specialty team to freely choose the discovery subjects offered or those offered in the basket according to the means, needs and interest of the training.

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,

V - Detailed program by subject of the S3 semester

Semester: 3
Fundamental EU Code: UEF2.1.1
Matter:Special electrical machines
VHS: 45h (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
Become familiar with the various other types of machines after having studied classic machines (symmetrical rotating MCC and MCA). Be able to understand their operating principle, characterize them and also classify them according to the main categories already seen.

Recommended prior knowledge:
Electric machine. Machine modeling.

Content of the subject:
- Introduction to special machines (01 weeks).;
- Asynchronous machines: Single-phase motors (squirrel cage, commutator; with frigger ring, etc.); Linear motor; multi-phase (>3) and multi-star machines (03 weeks);
- Synchronous machines: Synchromachines; Variable reluctance machines; Permanent magnet machines; Stepper motors; Superconducting machines (04 weeks);
- Vernier machines (low speed and high torque in motor and generator operation) (03 weeks)
- Brushless DC machines (1 week)
- Micromachines: Synchromachines (selsyns); Hysteresis synchronous motors; DC tachogenerators; Resolvers (03 weeks)..

Evaluation method:

- Continuous monitoring40%; Exam: 60%.

Bibliography:

Semester: 3
Fundamental EU Code: UEF2.1.1
Matter:Transient regimes of electrical machines
VHS: 45h (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
To be able to study the transient regimes in electrical machines, whether the regimes which are part of the operation of the machines such as starting or sudden accidents. The interest is obviously in the sizing of the power supply and protection devices of its machines but also in their design upstream.

Recommended prior knowledge:
Electrical circuits, electrical machines, Modeling of machines. Numerical analysis

Content of the subject:
I/ Transient regimes in linear electrical circuits. Direct current circuits. AC circuits**(02 weeks)..**
II/ Transient regimes in transformers. Powering up a transformer. Sudden short circuit of a transformer. Overvoltage in transformers. Electrodynamic forces in short circuit**(03 weeks)..**
III/ Transient regimes in direct current machines. Starting a shunt motor. Transient regimes of a shunt generator**(03 weeks)..**
IV/ Transient regimes in synchronous machines. Sudden short circuit at the terminals of an alternator. Dynamic stability of an asynchronous motor**(04 weeks)..**
V/ Transient regimes in asynchronous machines. Starting an asynchronous motor. Triggering an asynchronous motor. Sudden short circuit across the terminals of an asynchronous motor**(03 weeks)..**

Evaluation method:

- Continuous monitoring40%; Exam: 60%.

Bibliography:

Semester: 3
Fundamental EU Code: UEF2.1.1
Matter:Computer-aided design of electrical machines
VHS: 10:30 p.m. (Class: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives

The aim of this course is to provide students with an overview of the stages of computer-aided design with objectives and constraints duly recorded in the specifications. The optimization of electrical machines is often integral to the design.

Recommended prior knowledge

Electrical machines (Operation, Topologies and constructions). Basic electromagnetic modeling of electrical machines. Finite element method. Optimization methods.

Content of the material:

1. Principle and stages of designing an electrical machine**(02 weeks).**.
2. Design methods and tools**(02 weeks).**.
3. Specifications (specification of performance, constraints and operating limits)**(03 weeks).**.
4. Characterization of an electrical machine (main relationships, electrical calculation, mechanical calculation and thermal calculation)**(04 weeks)**.
5. Parametric example of electrical machine design (MS, MAS, etc.)
   - Determination of the electromagnetic field using FEM-based software
   - Improved performance by applying an optimization method)
   (04 weeks).

Evaluation method:

- Review: 100%.

Bibliography:

Semester: 3
Fundamental EU Code: UEF2.1.2
Matter:Identification and diagnosis of electrical machines
VHS: 10:30 p.m. (Class: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

The objective of this course is the determination by identification of the parameters of electrical machines with a view to their simulation and control. It will also enable the student to acquire essential knowledge to avoid breakdowns with a view to ensuring continuity of service. The methods

for diagnosing faults responsible for breakdowns are of two types: those based on a model and those which do not.

Recommended prior knowledge

Direct and alternating current electrical machines (Constitution, modeling and motor and generator operation), testing of electrical machines, equations of electrical circuits, signal theory and operational .calculation, numerical analysis

Content of the subject

Part 1 (07 weeks)

Chapter I. Methodologies for identifying electrical machine parameters.
I.1. General information on identification. (04 weeks)
I.2. Classic test method: measurement of resistance, self/mutual inductance at the stator and rotor, stator-rotor mutual inductance, mechanical parameters.
I.3. Special test method: (voltage index test, symmetrical short-circuit test, frequency test at standstill: SSFR method)

Chapter II. Parametric identification of electrical machines: (02 weeks)
II.1. Parametric identifications of the direct current machine.
II.2. Parametric identifications of the wound and cage asynchronous machine.
II.3. Parametric identifications of the synchronous machine.
II.4. Parametric identification of special electrical machines: MSAP, MRV.

Part 2 (08 weeks)
Chapter I. General information on faults in electrical machines and their diagnosis.
(01 weeks)
I.1. Failures of electrical machines. Mechanical failures. Electrical failures.
I.2. Presentation of diagnostic methods.

Chapter II. Modeling electrical faults in windings(04 weeks)
II.1. State modeling of inter-turn short circuit faults
II.2. State modeling of inter-coil and inter-phase short circuit faults.
II.3. . Modeling of unbalanced operation.
II.3 Applications, through projects, to electrical machines: MSAP, wound/cage MAS, MS, transformers, MRV.

Chapter III. Modeling of mechanical defects.(01 weeks)

Chapter IV. Model-free diagnostic methods: Signal processing approach. Parametric identification and state observation. Artificial intelligence methods (neural networks, fuzzy logic, etc.). (02 weeks)

Evaluation method:

- Review: 100%.

Bibliography:

Semester 3 Master:MachineryElectric

Semester: 3
Fundamental EU Code: UEF2.1.2
Matter:Heating and cooling of electromechanical actuators
VHS: 10:30 p.m. (Class: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives

The main objective of the course is to provide students with the bases and principles necessary to understand the different thermal aspects of which electromechanical actuators are the seat. The course also introduces students to thermal modeling of electrical machines.

Recommended prior knowledge

- Basics of mechanical construction of electrical machines
- Basics of fluid mechanics
- Basics of numerical methods

Content of the material:

1. General information on heat transfer (02 weeks)
1.1 Definitions: Temperature field, Temperature gradient, Heat flux
1.2 Formulation of a heat transfer problem: Energy balance
2. Heat transfer modes(06 weeks)
2.1 Heat transfer by conduction
- Fourier's law, Heat equation, Unidirectional transfer, Multidirectional transfer, Fins, Electrical analogy,
-

2.2 Heat transfer by convection
- Convection exchange coefficient, Natural convection, Forced convection

2.2 Heat transfer by radiation
Laws of radiation, Reciprocal radiation of several surfaces, Electrical analogy

3. Thermal modeling of electrical machines**(07 weeks)**
3.1 Heat equation
- Space-time boundary conditions
-Analog method: Thermal networks
-Numerical methods: Finite differences, finite volumes, finite elements

3.2 Evaluation of the parameters of the heat equation
- Heat sources
- Evaluation of thermal conductivity
- Thermal contact and insulation

3.3 Thermal contact modeling techniques
- Modeling using extended domains
- Modeling in the case of using equivalent materials

4.3 Modeling of the different flow modes relating to electrical machines
-Air gap
-Convection in axial rotor and stator channel
-External cooling: fins

Evaluation method:

- Review: 100%.

Bibliography:

Semester: 3
Fundamental EU Code: UEF2.1.2
Matter:Control of electrical machines
VHS: 45h (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Goals

• Know the different electrical systems of electric actuators (motor + mechanical loads and static converters)
• Be able to establish a simulation model of an electrical system including motor, power electronics and control
• Be able to simulate a model in the Matlab/Simulink environment
• Be able to size the correctors present in the motor controls using a suitable method

Content of the material:

1. Reminders on the operation of ace motorsassociated with mechanical loads (02 weeks).
2. Speed variators based on asynchronous and synchronous machines (03 weeks).
3. Vector control of permanent magnet synchronous machines (04 weeks)
4. Direct control of the torque of asynchronous motors (DTC) (03 weeks).
5. Order of morals step by step (03 weeks)

Evaluation method:

- Continuous assessment: 40%, Examination: 60%.

Bibliography:

Bibliographic references:

1. *Industrial electrical engineering, Guy Séguier and Francis Notelet, Tech et Doc, 1994*
2. *Power electronics, Guy Séguier, Dunod, 1990*
3. *Modeling and control of the asynchronous machine, JP Caron and JP Hautier, Technip, 1995*
4. *Control of Electrical Drives, W. Leonard, Springer-Verlag, 1996*
5. *Vector control of AC machines, Peter Vas, Oxford university press, 1990*
6. *Control of variable speed machines, Engineering Techniques, vol D3.III, n°3611, 1996*
7. *Electric actuators, Guy Grellet and Guy Clerc, Eyrolles, 1997*
8. *Vector control and DTC modeling, under the direction of C. Canudas de Wit, Hermes, 2000*

Semester: 3
Methodological EUCode: UEM2.1
Matter:TP - Special electrical machines
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives
The main objective is to deepen students' knowledge of the constitution and operating principles of special machines.

Recommended prior knowledge
Basic notions of traditional electrical machines.

Content of the material:

1- Universal Motor (comparison between the single-phase collector motor with series excitation and the DC motor with series excitation);

2- Single-phase asynchronous motor (study of the characteristics and different starting modes);

3- Asynchronous generator isolated and linked to the electrical network;

4- Synchronous machine with permanent magnets;

5- Synchronous machine with variable reluctance.

6- Brushless DC machine

Evaluation method: Review: 100%

Bibliographic references:

Lab brochure, course notes, lab documentation.

Semester: 3
Methodological EUCode: UEM2.1
Matter:TP - Transient regimes of electrical machines
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives

The main objective is to study the different transient regimes in electrical machines through simulation.

Recommended prior knowledge

Electric machine ; Modeling of electrical machines; Programming and simulation.

Content of the material:

1. Transient regimes in transformers;
2. Transient regimes in a direct current machine;
3. Transient regimes in an asynchronous machine;
4. Transient regimes in a synchronous machine.

Evaluation method: Ereview: 100%.

Bibliographic references:

1. J. Chatelain "Electric machines", Edition DUNOD, 1982.

2. P. Barret "Transient regimes of rotating electrical machines", Edition EYROLLES, 1982.

3.Lab brochure, course notes, lab documentation.

Semester: 3
Methodological EUCode: UEM2.1
Matter:TP - Control of electrical machines
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives

The main objective is to deepen students' knowledge of the different control strategies for electrical machines.

Recommended prior knowledge:

Basic notions of electrical machines, control and simulation.

Content of the material:

1- Simulation of vector control of an asynchronous squirrel cage machine;
2- Simulation of a hypo-synchronous cascade;
3- Simulation of vector control of a permanent magnet synchronous machine

Evaluation method: Eexamination: 100%

Bibliographic references:

Practical work brochure, course notes.

Semester: 3
Methodological EUCode: UEM2.1
Matter:TP: Identification and diagnosis of electrical machines
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Allow the student to familiarize themselves on the one hand with the methods of identifying the electrical and mechanical parameters of electrical machines, and on the other hand to immerse themselves in the diagnostic techniques of electrical machines through knowledge of the signatures of different defects.

Recommended prior knowledge

Electrical machines (operation, modeling, classic experiments); Electrical measurement; Theory/signal processing in a computer environment.

Content of the material:

Part 1: Identification by experimentation and/or computer tool

- Identification of electrical parameters by conventional tests;
- Identification of electrical parameters of machines by index tests;
- Identification of the mechanical parameters of electrical machines;

Part 2: Diagnosis and monitoring (IT tools)

- Diagnosis of faults in permanent magnet synchronous machine
- Diagnosis of faults in the wound asynchronous machine;
- Diagnosis of faults in the synchronous machine.
- Diagnosis of bar/ring breakage faults in the asynchronous machine cage ;

Evaluation method:

Continuous control: 100%

Bibliographic references:

1. TP brochure.
2. R. Abdessemed, "Modeling of electrical machines", Presses de l'Université de Batna,Algeria, 1997.
3. R. Abdessemed, "Modeling and simulation of electrical machines", Ellipses,Collection, 2011

Semester: 3
Methodological EUCode: UEM2.1
Matter:TP - Design of electrical machines
VHS: 15h (TP: 1h)
Credits: 1
Coefficient: 1

Goals :

The main objective of this practical work is to deepen students' knowledge ofhe design and static/dynamic electromagnetic modeling of different electrical machines through the use of CAD software based on numerical calculation (Finite element method).

Recommended prior knowledge:

Electric machine ; Simulation software.

Content of practical work (Minimum 4 TP):

TP N°1: Introduction to the software used for CAD of electrical machines;

TP No. 2: CAD: Actuator, Transformer, simplified version of electrical machines;

TP No. 3: CAD of permanent magnet synchronous machine

TP No. 4: CAD of a synchronous machine (with excitation coil);

TP No. 5: CAD of wound/cage asynchronous machine;

TP No. 6: CAD of a DC machine (classic, with magnets, Brushless);

Evaluation method:

Continuous control: 100%

Bibliographic references:

Practical work brochure, course notes.

Semester: 3
Teaching unit: UET 2.1
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 (02 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 (02 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 (01 Week)
- Research techniques
- Search operators

Chapter I-4: To process information (02 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 (01 Week)
- Systems for presenting a bibliography (The Harvard system, The Vancouver system, The mixed system, etc.)
- Presentation of documents.
- Citation of sources

Part II: Memory Design

Chapter II-1: Plan and stages of the dissertation (02 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 (02 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 **(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 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: ..
EU DiscoveryCode: UED..
Matter:**Maintenance and operational safety**
VHS:10:30 p.m.(Class: 1h30)
Credits: 1
Coefficient: 1

Content of the material:

I-History, context and definitions of SdF

II-Analysissystems with independent components (-Modeling of the malfunction logic by fault trees, -Qualitative and quantitative Boolean exploitation, -Limits of the method)

III- Analysis of systems taking into account certain dependencies (-Modeling of systems, -Markovian by state graphs, -Quantitative exploitation of the model, -Limit of the method)

IV- Analysis of systems with generalized consideration of dependencies (-Modeling using petrie networks (RdP), - Quantitative exploitation of the model: RdP: stochastic)

V- Application of operational safety methodologies (- reliability, - maintainability, - Availability, - security)

VI- Reliability forecast methodology (-Forecast calculation of reliability, - Analysis of failure modes, - fault diagnosis and maintenance techniques)

Evaluation method:

Review: 100%

Bibliographic references:

1. Patrick Lyonnet, "Reliability engineering, Edition TEC & DOC, Lavoisier, 2006.
2. Roger Serra, "Reliability and industrial maintenance", Course, ETS Higher Technology School, University of Quebec, 2013.
3. David Smith, Reliability, maintenance and risk, DUNOD, Paris 2006

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Semester: ..
Transversal EUCode: UED..
Matter:Industrial security and authorization
VHS:10:30 p.m.(Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The subject aims to inform the future Master in High Voltage Technology on the nature of electrical accidents, the methods of rescuing electrical accidents and to give them sufficient knowledge to enable them to best size the equipment protection devices. and personnel working in industry and other areas of use of this equipment.

Recommended prior knowledge:

Electric energy transport and distribution networks.

Content of the material:

1) Electrical risks (history, standards, statistics on electrical accidents);

2) Nature of electrical accidents and dangers of electric current;

3) Protective measures (protection of people and equipment);

4) Safety measure against the indirect effects of electric current (harmful materials, fire, explosions, etc.);

5) Relief measure and care.

Evaluation method: Review: 100%

Semester: ..
Transversal EUCode: UED..
Matter:Standards and legislation in Electrotechnics
VHS:10:30 p.m.(Class: 1h30)
Credits: 1
Coefficient: 1

Content of the material:

Part I: Management

I. Types of Businesses to Run
   Traditional, profit-oriented business;
   Non-profit organizations: Administrations, Hospitals, International organizations

II. Business management tools
   Methods for analyzing and understanding socio-economic phenomena;
   Decision making in a changing and complex economic environment

III. Examples of policies and management concepts
   Lean management;
   Benchmarking

Part II: Standard in electrical engineering
   Different standardization organizations
   French NFC standard
   European standard EN
   IEC international standard
   Standards and symbols

Part III: Certification

I. Implementation of a quality management system (QMS)
   How to do ?
   To do what ?

II. Quality a way to make the business prosper
   2-1 Quality policy (PQ);
   2-2 Quality approach (DM);
   2-3 Quality management manager (RMQ);
   2-4 PCDA Tool (Plan, Do, Check, Act)

III. Certification process
   Certification of the ISO9001 standard,
   Steps to follow,
   Awareness, diagnosis, Actions,
   Audit and technical certification file

Evaluation method:

Review: 100%.

Semester: ..
EU Discovery Code:UED..
Matter:Industrial data
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

This subject allows students of this master's degree to become familiar with the field of industrial computing. They will acquire the notions of communication protocols.

Recommended prior knowledge:

Combinatorial and sequential logic, µ-processors and µ-controllers, computer science.

Material content:

Chapter 1 : Introduction to industrial computing; **(02 weeks)**

Chapter 2 : Connecting the hardware to a µP; **(02 weeks)**

Chapter 3: Peripherals and interfaces (Ports, Timers, etc.); **(04 weeks)**

Chapter 4: Serial communication bus (RS-232, DHCP, MODBUS, I2C); **(05 weeks)**

Chapter 5: Data acquisition: CAN and CNA peripherals; **(02 weeks)**

Evaluation method:

Review: 100%

Bibliographic references:

1. Baudoin, Geneviève & Virolleau, Férial, "The DSP family, TMS 320C54X [printed text]: application development", Paris: Francis Lefebvre, 2000, ISBN: 2100046462.
2. Pinard, Michel, "DSPs, ADSP218x family [printed text]: principles and applications", Paris: Francis Lefebvre, 2000, ISBN: 2100043439;
3. Tavernier, Ch., "PIC microcontrollers: applications", Paris: Francis Lefebvre, 2000, ISBN: 2100059572;
4. Tavernier, Ch., "PIC microcontrollers: description and implementation", Paris: Francis Lefebvre, 2004, ISBN: 2100067222;
5. Cazaubon, Christian, "HC11 microcontrollers and their programming", Paris: Masson, [sd], ISBN: 2225855277;
6. Tavernier, Christian, "AVR microcontrollers: description and implementation", Paris: Francis Lefebvre, 2001, ISBN: 2100055798;
7. Dumas, Patrick, "Industrial computing: 28 practical problems with course reminder", Paris: Francis Lefebvre, 2004, ISBN: 2100077074.

Semester ..:
EU DiscoveryCode: UED…
Matter:Industrial Ecology and Sustainable Development
VHS:10:30 p.m.(Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives

Raise awareness of sustainable development, industrial ecology and recycling.

Recommended prior knowledge:

Content of the material:

- Birth and evolution of the concept of industrial ecology
- Definition and principles of industrial ecology
- Industrial ecology experiences in Algeria and around the world
- Industrial symbiosis (eco-industrial parks/networks)
- Gaseous, liquid and solid waste
- Recycling

Evaluation method:

Review: 100%.

Bibliographic references:

1 *Industrial and territorial ecology, COLEIT 2012, fromJunqua Guillaume,Brullot Sabrina*
1 *Towards an industrial ecology, how to put sustainable development into practice in a hyper-industrial society, SurenErkman 2004*
2 *Energy and its control. Montpellier Cedex 2: CRDP of Languedoc-Roussillon, 2004. . ISBN 2-86626-190-9,*
3 *Appropriations of sustainable development: emergences, diffusions, translationsB Villalba - 2009*

Semester ..:
EU DiscoveryCode: UED…
Matter:**Renewable Energies**
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives

Provide students with the scientific foundations allowing them to integrate the scientific research community in the field of renewable energies, batteries and sensorsassociated with engineering applications.

Recommended prior knowledge:

Energy conversion devices and technologies -

Content of the subject

VSchapter 1: Introduction to renewable energies (Renewable energy sources: deposits and materials **(4 weeks)**
Chapter 2 : Solar energy (photovoltaic and thermal) **(4 weeks)**
Chapter 3: Wind power **(3 weeks)**
Chapter 4: Other renewable sources: hydraulic, geothermal, biomass… **(2 weeks)**
Chapter 5: Storage, fuel cells and hydrogen **(2 weeks)**

Evaluation method:

Review: 100%.

Bibliographic references:

1. *Sabonnadière Jean Claude. New energy technologies 1: Renewable energies, Ed. Hermès.*
2. *Gide Paul. The great book of wind power, Ed. Moniteur.*
3. *A. Labouret. Photovoltaic Solar Energy, Ed. Dunod.*
4. *Viollet Pierre Louis. History of hydraulic energy, Ed. Press ENP Chaussée.*
5. *Weigh Felix A. Solar thermal installations: design and implementation, Ed. Monitor.*

Semester: ..
UE Discovery Code: UED ..
Matter:**Electrical engineering materials**
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The objective of this course is to provide the basic knowledge necessary to understand the physical phenomena occurring in materials and to make an appropriate choice for the design of electrical components and systems. The fundamental characteristics of different types of materials as well as their behavior in the presence of electric and magnetic fields are covered.

Recommended prior knowledge:

Fundamental physics and applied mathematics.

Content of the subject

VSchapter 1: Know and understand the operation, constitution, technology and specification of electrical equipment used in electrical networks.**(03 weeks)**
VSchapter 2: Magnetic materials: properties, losses, types, thermal and mechanical properties, characterization, magnets.**(04 weeks)**
VSchapter 3: Conductive materials: properties, losses, insulation, testing and applications.**(04 weeks)**
VSchapter 4: Dielectric materials: properties, losses, breakdown and performance, constraints, tests. **(04 weeks)**

Evaluation method:

Review: 100%.

Bibliographic references:

1. AC Rose-Innes and EH Rhoderick, Introduction to Superconductivity, Pergamon Press.
2. P. Tixador, Superconductors, Editions Hermès, Materials Collection, 1995.
3. P. Brissonneau, Magnetism and Magnetic Materials Editions Hermès.
4. P. Robert, Electrotechnical Materials, Volume II, Treatise on Electricity, Electronics and Electrotechnics of the Ecole Polytechnique Fédérale de Lausanne, Edition Dunod.
5. Engineering techniques.
6. R. Coelho and B. Aladenize, Dielectrics, Treatise on New Technologies, Materials series, Editions Hermès, 1993.
7. M. Aguet and M. Ianoz, High Voltage, Volume XXII, Treatise on Electricity, Electronics and Electrotechnics of the Federal Polytechnic School of Lausanne, Edition Dunod.
8. C. Gary et al, The dielectric properties of air and very high voltages, Collection of the Department of Electricity Studies and Research of France, Edition Eyrolles, 1984.
9. Dielectric Materials for Electrical Engineering, Volume 1 & 2, HERMES LAVOISIER, 2007.

Semester: ..
EU Discovery Code:UED…
Matter:Implementation of real-time digital control

VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

This teaching unit deals with the digital control of machine converter assemblies using programmable components (μControllers, DSP, ARM, FPGA).

Recommended prior knowledge:

μ-processors and μ-controllers, IT, Control, Electrical machines, Power converters.

Content of the material:

Chapter 1 : Description of real-time systems; (03 weeks)

Chapter 2 : Digital control of systems; (04 weeks)

Chapter 3: Study of the implementation of MLI techniques on a digital processor; (04 weeks)

Chapter 4: Examples of implementing machine controls: Direct Current Machine, Asynchronous Machine, Synchronous Machine. (04 weeks)

Evaluation method:

Review: 100%.

Bibliographic references:

1. B. Bouchez "Digital audio applications of DSP: Theory and practice of digital processing", Elektor, 2003.
2. Baudoin, Geneviève & Virolleau, Férial, "The DSP family, TMS 320C54X [printed text]: application development", Paris: Francis Lefebvre, 2000, ISBN: 2100046462.
3. Pinard, Michel, "DSPs, ADSP218x family [printed text]: principles and applications", Paris: Francis Lefebvre, 2000, ISBN: 2100043439;
4. Tavernier, Ch., "PIC microcontrollers: applications", Paris: Francis Lefebvre, 2000, ISBN: 2100059572.

Semester: ..
EU Discovery Code:UED..
Matter:Quality of electrical energy
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

- Study the main phenomena which deteriorate the Quality of Electrical Energy (EQE), their origins and the consequences on equipment through the degradation of voltage and/or current and disturbances on the networks.
- Understand the implication of non-linear loads in the deterioration of energy quality and learn about the main solutions to improve it by remedying disturbances by eliminating them or mitigating them when they are unavoidable.

Recommended prior knowledge:

Electrical networks, harmonics, filters,Fundamental electrical engineering, Power Electronics.

Material content:

Chapter 1: Introduction to Power Quality (EQE) (03 weeks)
Context,definition and terminology of energy quality,Objectives of the mmeasurement of QEE.

Chapter 2: Degradation of power quality (05 weeks)
Most common power quality issues and effects on loads and processes

- Voltage dips and outages: Origins of voltage dips and overvoltages, Consequences on receivers, Flicker concepts.
- Harmonics and interharmonics: Origins of harmonics. Nonlinear loads, Impacts of harmonics on the network and receivers.
- Voltage variations and fluctuations:Internal/external origins of outages, Consequences on production and equipment.
- Transient phenomena: EMC concepts, Lightning strikes, Equipotentiality, PE protective conductor.
- Imbalances.

Chapter 3: Power quality level - Standards (03 weeks)
Voltage characteristics. Terminology, Voltage parameter measurement strategy, standards, Network analyzers.

Chapter 4: Solutions to improve power quality (04 weeks)
Reduction in the number of voltage dips and outages, Reduction in the duration and depth of voltage dips, Sensitization of installations, Use of static uninterruptible power supplies (UPS), etc.
Reduction of harmonic currents generated: Modification of the installation, Passive filtering, Active filtering, Hybrid filtering, etc.
Remedies for protection against temporary overvoltages, switching overvoltages (shock choke, static automatic compensator), atmospheric overvoltages (lightning), etc.
Voltage fluctuations: Changing lighting mode, changing motor starting mode, changing the network, etc.
Imbalances: Balance the single-phase loads on the three phases, Increase the powers of the transformers and the section of the cables upstream of the unbalance generators, Protection of the machines, Use of LC loads (Steinmetz assembly),..

Evaluation method:

Review: 100%

Bibliographic references:

1. Guide to Quality of Electrical Supply for Industrial Installations Part 2: Voltage Dips and Short Interruptions Working Group UIE Power Quality 1996.
2. GJ Wakileh, Power system harmonics-Fundamental Analysis and Filter Design, Springer-Verlag, 2001.
3. A. Kusko, MT. Thompson, Power Quality in Electrical Systems, McGraw Hill, 2007.
4. F. Ewald Fuchs, MAS Masoum, Power Quality in Power Systems and Electrical Machines, Elsevier Academic Press, 2008.
5. RC Dugan, Mark F. Granaghan, Electrical Power System Quality, McGraw Hill, 2001.
6. Scheider technical notebooks No. CT199, CT152, CT159, CT160 and CT1.
7. A. Robert, Supply Quality Issues at the Interphase between Power System and Industrial Consumers, PQA 1998.
8. Energy quality, Course by Delphine RIU, INP Grenoble.

Semester: ..
EU Discovery Code:UED…
Matter:Artificial intelligence techniques
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

The main motivation of this subject is the implementation of an introduction of the capabilities offered by Artificial Intelligence Techniques "TIA" as new and improved techniques, with a view to developing approaches for the study of electric machine. At the end of the module, students must master the concepts relating to TIA, know how to manipulate them with the theory of electrical machines, and use the software toolboxes for the purposes of modeling, identification, design optimization, diagnosis and synthesis of simple, efficient and robust control laws). The results published in research work are used to draw some practical examples.

Recommended prior knowledge:

Mathematics, electrical engineering and systems theory. (Presentation of electrotechnical systems, Fourrier, Laplace and Z transformations, Electrical machines-types and theories).

Content of the material:

Optimization byneural networks (NN);

Optimization byfuzzy logic (LF);

Optimization bygenetic algorithms (GA);

Particle Swarm Optimization (PSO).

HYBRID APPROACHES: Introduction-Neuro network-blur (ANFIS, SANFIS)-Radial basis network-vague-Optimization of fuzzy systems by genetic algorithms-Application areas-Examples.

Semester: ..
EU Discovery Code:UED…
Matter:Technical drawing
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

With the aim of representing through drawings and designing structures such as electrical machines, transformers or others, this course will allow studentsto acquire the basic principles for the representation of parts in industrial drawing,to design electrical machines while respecting standardized conventions to ensure the construction represented is as imagined by the designer.

Recommended prior knowledge:

Electric machine.

Content of the subject:

CHAPTER I: GENERAL INFORMATION ON TECHNICAL DRAWING

1. main types of industrial designs
2. formats
3. permanent elements
4. scale
5. the cartridge
6. nomenclature
7. writing
8. traits

CHAPTER II: GEOMETRIC REPRESENTATION OF PARTS

1. cavalier perspective
2. projections and views
3. simple cuts – hatching
4. section

CHAPTER III: VOLUME REPRESENTATION

1. volume modeler
2. creation of elementary volumes
3. creation of a simple part
4. Creating a Simple Assembly
5. creation of an assembly of rotating electric machines

Evaluation method:

Review: 100%.

Bibliographic references:

1. Industrial designer's guide Chevalier A. Edition Hachette Technique;
2. Technical drawing 1st part descriptive geometry Felliachi d. and Bensaada s. Edition OPU Algiers;
3. Technical drawing part 2 industrial drawing Felliachi d. and bensaada s. Edition OPU Algiers;
4. First notions of technical drawing Andre Ricordeau Edition AndreCasteilla

Semester: ..

EU Discovery Code:UED…
Matter:Trams
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Understand the tram environment and its specificities.

Recommended prior knowledge:

General electromechanics, electrical circuits.

Content of the subject:

Chapter 1: General information on trams
·First generation trams
·New tram systems
·Equipment presentation
·Trams around the world

Chapter 2: Electrical installations of trams
·Power supply network structures
·Energy storage and on-board production
·Modern techniques for energy storage

Chapter 3: System modeling and control
·System modeling
·Control technique used

Chapter 4: signaling
·Signaling concepts

Evaluation method:
Review: 100%.

Semester: ..
UE Discovery Code: UED ..
Matter: Electrical machines in dynamic mode
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Allow the student to acquire knowledge concerning the modeling of synchronous and asynchronous machines in dynamic regime

Recommended prior knowledge:

Mathematics, operation of electrical machines in steady state.

Content of the material:

Chapter 1: Model of the synchronous machine in dynamic mode

- Constitution of the synchronous machine and phenomena involved in its operation – simplifying hypotheses
- Equations for stator and rotor voltages in the real axis (salient pole machine)
- Flux equation - Calculation of inductances - case of the smooth pole machine - Mechanical equation and calculation of the electromagnetic torque - problem linked to the resolution of the system
- Axis transformation – Concordia – Park
- Model of the machine in the Park frame – expression of the electromagnetic torque – advantage of the Park model – state model
- Limitations of the model obtained

Chapter 2: Model of the asynchronous machine in dynamic mode

- Constitution of the asynchronous machine andphenomena involved in its functioning – simplifying hypotheses
- Equations for stator and rotor voltages in the real axis - (wound rotor machine)
- Flux equation - Calculation of inductances - case of the cage rotor machine - Mechanical equation and expression of the electromagnetic torque
- Model of the machine in the Park frame - Different types of position of the frame – expression of the electromagnetic torque – state model
- Limitations of the model obtained

Evaluation method:

Review: 100%.

Bibliographic references:

1. Modeling and control of the asynchronous machine, JP Caron and JP Hautier, Technip, 1995
2. Control of Electrical Drives, W. Leonard, Springer-Verlag, 1996
3. Vector control of AC machines, Peter Vas, Oxford University Press, 1990
4. Methods for controlling electrical machines, R. Husson, Hermès.
5. Power Electronics and AC Drives, Prentice-Hall, BK Bose, 1986
6. Modern Power Electronics and AC Drives, BK. Bose, Prentice-Hall International Edition, 2001.
7. Electric actuators, Guy Grellet and Guy Clerc, Eyrolles, 1997
8. Control of asynchronous motors, Modeling, Vector control and DTC, Volume 1, C. Canudas De 9.

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