الجمهورية الجزائرية الديمقراطية الشعبية People's Democratic Republic of Algeria
وزارة التعليم العالي و البحث 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***	***Electrical Controls***

الجمهورية الجزائرية الديمقراطية الشعبية People's Democratic Republic of Algeria
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National Educational Committee for the field of Science and Technology

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مواءم

برنامج وطني

تـحديـث2022

الميدان	الفرع	التخصص
علوم و تكنولوجيا	كهروتقني	تحكمكهربائي

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	Electrical controls	Electrical engineering	**1**	**1.00**
		Electromechanics	**2**	**0.80**
		Automatic	**3**	**0.70**
		Industrial maintenance	**3**	**0.70**
		Other licenses in the ST domain	**5**	**0.60**

II – Half-yearly teaching organization sheets of the specialty

Semester 1 Master: Electrical Controls

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	Basket of your choice	1	1	1h30			10:30	02:30		100%
	Basket of your choice	1	1	1h30			10:30	02:30		100%
Transversal EU Code: UET 1.1 Credits: 1 Coefficients: 1	Technical English and terminology	1	1	1h30			10:30	02:30		100%
Total semester 1		**30**	**17**	**12:00**	**6:00**	**7:00**	**375h00**	**375h00**		

				p.m.	a.m.	a.m.				

Semester 2 Master: Electrical Controls

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: 10 Coefficients: 5	Modeling and identification of electrical systems	4	2	1h30	1h30		45:00	55:00	40%	60%
	Electrical control techniques	6	3	3:00	1h30		67h30	82h30	40%	60%
Fundamental EU Code: UEF 1.2.2 Credits: 8 Coefficients: 4	Sampled servos and digital regulation	4	2	1h30	1h30		45:00	55:00	40%	60%
	Fault diagnosiscontrol systems	4	2	1h30	1h30		45:00	55:00	40%	60%
Methodological EU Code: UEM 1.2 Credits: 9 Coefficients: 5	TP Modeling and identification of electrical systems	2	1			1h30	10:30	27:30	100%	
	TP Electrical control techniques	3	2			2h30	37:30	37:30	100%	
	TPSampled servos and digital regulation	2	1			1h30	10:30	27:30	100%	
	TPFault diagnosiscontrol systems	2	1			1h30	10:30	27:30	100%	
EU Discovery Code: UED 1.2 Credits: 2 Coefficients: 2	Basket of your choice	1	1	1h30			10:30	02:30		100%
	Basket 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**	**12:00**	**6:00**	**7:00**	**375h00**	**375h00**		

Semester 3 Master: Electrical Controls

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 2.1.1 Credits: 8 Coefficients: 4	**Nonlinear and advanced control**	**6**	**3**	**3:00**	**1h30**		**67h30**	**82h30**	**40%**	**60%**
	Programmable controllers	**2**	**1**	**1h30**			**10:30**	**27:30**		**100%**
Fundamental EU Code: UEF 2.1.2 Credits: 10 Coefficients: 5	Artificial intelligence techniques	4	2	1h30	1h30		45:00	55:00	40%	60%
	Electrical control of industrial mechanisms	6	3	3:00	1h30		67h30	82h30	40%	60%
Methodological EU Code: UEM 2.1 Credits: 9 Coefficients: 5	**TP Nonlinear and advanced control**	**4**	**2**			3:00	45:00	55:00	100%	
	TP Artificial intelligence techniques / TP Implementation of real-time digital control	2	1			1h30	10:30	27:30	100%	
	TP Electrical control of industrial mechanisms	2	1			1h30	10:30	27:30	100%	
	Programmable automation TPindustrial (API)	**1**	**1**			1h00	3:00	10:00	100%	
EU Discovery Code: UED 2.1 Credits: 2 Coefficients: 2	Basket of your choice	1	1	1h30			10:30	02:30		100%
	Basket 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**		

Other Discovery Units (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- Special machines
9- Industrial ecology and sustainable development
10- Transient regimes of electrical systems
11- Industrial automation
12- Control of future energy systems
13- Electrical machines in dynamic mode
14- Industrial automation and IT
15- Others...

Semester 4

Internship in a company culminating in a dissertation and a defense.

	VHS	coefficient	Credits
Personal work	550	09	18
Internship in company	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 values (jury assessment) /6
- Writing of the dissertation (jury assessment) /4
- Presentation and response to questions (Jury assessment) /4
- Appreciation of the supervisor /3
- Presentation of the internship report (Jury assessment) /3

III - Detailed program by subject for the S1 semesters

Semester: 1
Fundamental EU Code: UEF 1.1.1
Matter:electrical energy transport and distribution networks
VHS: 45h (lesson: 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 course of 'Electric networks' in license, and on the other hand the introduction of the necessary knowledge on management and operation electrical networks.

Recommended prior knowledge:

The fundamental laws of electrical engineering (Ohm's law, Kirchhoff's laws, etc.), the analysis of alternating current electrical circuits, complex calculation and modeling of electrical lines (licensed electrical networks course).

Material content:

Chapter 1: Architectures of electrical substations (02 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 electrical energy transport
2.1. Energy transmission lines (03 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 (02 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 electrical networks(03 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 (02 weeks)
Neutral regimes (insulated, earthed, impedant), artificial neutral.
Chapter 5: Adjusting the tension (03 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 control: 40%; Exam: 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 deep understanding of their working 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
(02 weeks)
Idealized characteristic of different types of semiconductors, logical equations of semiconductors, simulation methods of static converters
Chapter 2: Switching mechanisms in static converters (03 weeks)
Natural switching principle, forced switching principle, calculation of switching losses.
Chapter 3: Design methods for static converters with natural switching
(02 weeks)
Switching rules, definition of the switching cell, different types of sources, power exchange rules, direct and indirect converters example: study of a cyclo converter.
Chapter 4: Design methods for forced switching static converters
(03 weeks)
- PWM inverter
- Sinusoidal absorption rectifier
- PWM dimmer
- Switching power supplies

Chapter 5: Multi-level inverter (03 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 (03 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(03 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(02 weeks)
General, The instruction set, Programming method.
Chapter 3: Interrupts and I/O interfaces(03 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(03 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(04 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:

Review: 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. *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
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 (03 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 (04 weeks)

Generalities and equations of the synchronous machine with smooth poles. Study of the operation of the synchronous machine. Different 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 and Parallel Coupling. Synchronous motors, starting…

Chapter 3: Asynchronous machines (04 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 (04 weeks)
Structure of direct current machines. Equations of DC machines. Starting, braking and speed adjustment modes for 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.*

5. *PS Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 2008.*
6. *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 (TP: 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 microcontroller (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 (01 week)
TP2: Programming arithmetic and logic operations in a µ-processor **(01 week)**
TP3: Use of video memory in a µ-processor (01 week)
TP4: Management of µ-processor memory. (02 weeks)
TP5: Control of a stepper motor by a µ-processor (02 weeks)
TP6: Screen management (01 week)
TP7: Programming the PIC µ-microcontroller (02 weeks)
TP8: Control of a stepper motor by a PIC µ-microcontroller (02 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. *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*
6. *P. Mayeux Learn Mid Range PIC programming through experimentation and simulation DUNOD 2010*
7. *A. Reboux. Getting started with PIC Basic and assembler programming – DUNOD**2002***

Semester: 1
Methodological EUCode: UEM 1.1
Matter:**TP: Electric 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 student to 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*
4. *corrected", ,: MARKETING ELLIPSES*

Semester: 1
Methodological EUCode: UEM 1.1
Matter:TP Applied 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 associated 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 function with several variables 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

Teaching objectives:

Complete, consolidate and verify the knowledge already acquired in the course.

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 two discovery subjects offered on the repository or to choose other discovery subjects among those offered according to the 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 from 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 of the S2 semester

Semester: 2

Fundamental EU Code: UEF 1.2.1
Matter:Modeling and identification of electrical systems
VHS: 45h (Class: 1h30, tutorial 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Acquire and master fundamental notions and basic methods for developing representation models describing input-output behavior based on experimental measurements and techniques for identifying a process to be controlled with a view to developing a system high performance regulation.

Recommended prior knowledge:

Mathematical bases and controlled systems.

Material content:

Chapter 1: Systems and experiments (01 week)
General, types of models, models and simulation, how to obtain a model

Chapter 2: Mathematical model (02 weeks)
Block diagram of a system, characteristic variables, internal and external representations of a system

Chapter 3: Modeling of electrical systems(02 weeks)
Modeling of a passive component, an active component and basic electrical circuits, Examples of applications.

Chapter 4: Modeling Tools(02 weeks)
Bond graph (BG) or Causal Information Graph (GIC)) (Application to electrical circuits

Chapter 5: General information on identification(02 weeks)
- Definitions, steps, SBPA generation, choice of model structure (AR, ARMA, ARMAX..);
- Reminder of basic methods in Automatic:Temporal response of a system, Frequency approach, Direct identification from the temporal and frequency responses of 1st order and 2nd order systems, instrumental variable method;
- Principle of model adjustment:Linear model versus parameters, Minimization of the adjustment criterion and calculation of the optimal solution.

Chapter 6: Graphical identification methods(02 weeks)
Strejc method, Broida method…

Chapter 7: Digital Identification Methods(02 weeks)
Recursive methods, non-recursive method.

Chapter 8: Estimation and observation (02 Weeks)
- Estimation of electrical systems (example: Gopinath estimator)
- Deterministic observation (Luenberger observer)
- Non-deterministic or stochastic observers (Kalman filter)

Evaluation method:

Continuous control: 40%; Exam: 60%.

Bibliographic references:

1. ID Landau, “Identification of systems”, Hermès, 1998.
2. E. Duflos, Ph. Vanheeghe, “Estimation Prediction”, Technip, 2000.
3. T. Soderstrom, P. Stoica, “System Identification”, Prentice Hall, 1989.
4. R. Hanus, “Identification with automaticity”, DE Boeck, 2001.

5. L. Lennart, "System Identification: Theory for the User", Second edition, Prentice Hall 1999.
6. P. Borne, Geneviève Dauphin-Tanguy, Jean-Pierre Richard, "Process modeling and identification", Technip, 1992.
7. R. Ben Abdenour, P. Borne, M. Ksouri, M. Sahli, “Identification and digital control of industrial processes”, Technip, 2001.
8. E. Walter, L. Pronzato, "Identification of Parametric Models from Experimental Data", Springer, 1997.

Semester: 2
Fundamental EU Code: UEF 1.2.1
Matter: Electrical control techniques
VHS: 67h30 (Class: 3h00, tutorial 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:

- Acquire the fundamental knowledge enabling the design of a motor chain (motor and power electronics) for variable speed drive, meeting predefined specifications, based on direct or alternating current machines.
- Size the PID correctors necessary for controlling electrical machines, according to specifications, using a suitable method.
- Evaluate and compare the performance of different command-control strategies.

Recommended prior knowledge:

Mathematics, basic knowledge of electrical machines, power electronics converters and servo theory.

Material content:

Chapter 1: Variable speed electric drives (01 weeks)
Architecture of a drive system, The interest of variable speed their structures, Comparison of different drives.

Chapter 2: Modeling asynchronous and synchronous machines for their control (04 weeks)

Different three-phase-two-phase transformations, Dynamic models of Asynchronous and Synchronous machines in Park's two-phase benchmark, Functional diagrams.

Chapter 3: Control and command strategies for asynchronous machines (05 weeks)
- Reminders on scalar control,
- Vector control: Principle of vector control, Choice of frame of reference and control strategy, Vector control with oriented rotor flux, Vector control with oriented stator flux.
- Laws of direct control of the torque of the asynchronous motor: Control strategies, Torque control, Power control.

Chapter 4: Control and control strategies for synchronous machines (05 weeks)
Problem of starting synchronous machines, Machine-converter association, The synchronous motor in variable speed, Self-piloting, Vector control, Torque control of the synchronous machine, DPC control of the MS.

Evaluation method:

Continuous control: 40%; Exam: 60%.

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. Wit, Edition Hermès Sciences, Lavoisier, Paris**2004**.

Semester: 2

Fundamental EU Code: UEF 1.2.2
Matter: Sampled controls and digital regulation
VHS: 45h00 (Class: 1h30, tutorial 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Know sampling, the difference between continuous system, sampled system and discrete system. Know and master the mathematical tool "z transform". Know discrete models. Analyze sampled systems (discrete) and synthesize digital regulators (discrete) PID, RST and status feedback. Know how to implement digital regulators (discrete).

Recommended prior knowledge:

Know sampling, the difference between continuous system, sampled system and discrete system. Know and master the mathematical tool "z transform". Know discrete models. Analyze sampled systems (discrete) and synthesize digital regulators (discrete) PID, RST and status feedback. Know how to implement digital regulators (discrete).

Material content:

Chapter 1: Structure of a digital control system (01 Week)
Historical. Advantages and disadvantages of digital control. General structure of a digital control system. A/D and D/A conversions. Samplers/blockers.

Chapter 2 :Sampling and reconstitution (01 week)
Sampling. Shannon's sampling theorem. Practical considerations. Signal reconstruction.

Chapter 3:Z transform: properties and applications (02 weeks)
Definitions. Properties of the z transform. Z-transform of some signals. Inverse z transform. Application examples.

Chapter 4:Sampled systems (discrete) (02 weeks)
Definitions. Representation by difference equations. Lead/lag operators. Representation by the impulse response. Representation by discrete transfer function (Transmittance in Z). Representation in state space. Block diagram algebra (block/diagram simplification).

Chapter 5: Analysis of sampled systems (03 Weeks)
Introduction. Stability, precision, stability precision dilemma. Temporal analysis (impulse response, index response, etc., effects of poles and zeros). Frequency analysis. Stability criteria (Schur-Cohn, Jury, Routh-Hurwitz, Discrete Nyquist, Discrete Evans Locus).

Chapter 6:Control by digital PID regulator (02 weeks)
Continuous PID, discretization of continuous PID. Synthesis in the Z plane. Practical implementation of PID regulators.

Chapter 7:Digital RST order (02 weeks)
Summary in the continuous case. Synthesis in the discrete (sampled) case. Practical implementation of RST regulators.

Chapter 8:Digital control by status feedback (02 weeks)
Summary in the continuous case. Synthesis in the discrete (sampled) case. Practical implementation of regulators by status feedback.

Evaluation method:

Continuous control: 40%; Exam: 60%.

Bibliographic references:

1. JR Ragazzini, GF Franklin, “Sampled servo systems”, Dunod, 1962.
2. D. Viault, Y. Quenec'hdu, “Sampled servo systems”, ESE, 1977.
3. C. Sueur, P. Vanheeeghe, P. Borne, “Automatics of sampled systems: course elements and solved exercises”, Technip, December 5, 2000.
4. P. Borne. GDTanguv. JP Richard. F. Rotella, I. Zambetalcis, "Analysis and regulation of industrial processes-digital regulation", Volume 2-Editions Technip, 1993.
5. Emmanuel Godoy, Eric Ostertag, "Numerical control of systems: Frequency and polynomial approaches", Ellipses Marketing, 2004.
6. H. Buhler, “Sampled Settings”, Volume 1, Edition Dunod.
7. Dorf & Bishop, "Modern Control Systems", Addison-Wesley, 1995
8. J. L Abatut, “Sampled Linear Systems and Controls”, Edition Dunod.
9. T. J. Katsuhiko, “Modern Control Engineering,” 5th Edition, Prentice Hall.
10. R. Longchamps, “Numerical Control of Dynamic Systems”, Presse Polytechnique, 2006.

Semester: 2
Fundamental EU Code: UEF 1.2.2
Matter: Diagnosis of control system failures

VHS: 45h00 (Class: 1h30, tutorial 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The diagnosis of industrial failures is based on knowledge of the symptom(s) to determine the cause(s). This material allowsfor the student to acquire essential knowledge for avoiding breakdowns for the sake of reliability and continuity of service in an electrical control system.

Recommended prior knowledge:

Electrical machines, Electric circuits, Signal theory, Numerical analysis

Material content:

Chapter 1 :Introduction to fault diagnosis techniques (03 Weeks)

Definitions: AWhatit serves a diagnosis, Normal operation, Breakdown and fault, Failure, Disturbance, Residue, Detection, Fault location, Fault identification, Signature, Monitoring, Supervision.
Diagnostic methodology: how to make a diagnosis? Logical steps of troubleshooting, location of the defective element under voltage and under voltage, diagnosis and search for the cause.
Intervention methodology: permanent monitoring, inspection, replacement of the defective element and checks, Intervention report, Fault classification: location, modeling, temporal characteristics, monitoring using models: physical (hardware) redundancy, analytical redundancy, fault detection and isolation (***FDI***), principle of diagnosis: diagnostic architecture, Generation of model-based residues: Obtaining signature tables, Model-based diagnostic methods, Approaches based on state observers.

Chapter 2 :Failure diagnosis tools (02 Weeks)

Sensors, Signal visualization, signal processing, spectral analysis: Tools and techniques.

Chapter 3:Inspections, directives, interventions (03 Weeks)

Specificity of industrial installations in terms of inspections, Diagnosis of control and power equipment, Use of manufacturer data and reference values, Control of the degradation curve and situation of operating thresholds.

Chapter 4: Preventive maintenance of equipment (02 Weeks)

Reading ofdiagramselectrical composed of power, control and/or remote control circuits. Periodic checking of connector tightness, conductor condition, overheating. Control of leakage currents, nominal current, voltage.

Chapter 5:Diversified practical case studies (03 Weeks)

Motor, conveyor, control system.

Chapter 6: Introduction to diagnosis using intelligent methods (02 Weeks)

Expert systems, State graphs, Fuzzy logic, Neural networks, Genetic trees, ...

Evaluation method:

Continuous control: 40%; Exam: 60%.

Bibliographic references:

1. J. Montmain, J. Ragot, D. Sauter, Supervision of complex processes, Lavoisier, 2007.
2. L. Ljung, Systems Identification: theory for the User. Prentice-Hall, 2nd edition, 1999.
3. PSR Murty, Power System Analysis, BS Publications, 2007.
4. D. Brown, D. Harrold, R. Hope, Control System Power and Grounding Better Practice, Elsevier, 2004.
5. G. Cullman, Elements of Informational Computing, Electrical-Mechanical Engineer's Library. Ed. Albin Michel.
6. JD Glover, MS Sama, TJ Overbye, “Power Systems Analysis and Design”, 4th Edition, Thompson-Engineering.

Semester: 2
EU Methodological Code:UEM 1.2
Matter: TP Modeling and identification of electrical systems
VHS: 10:30 p.m. (TP 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Implement the different identification techniques studied to model or identify the internal parameters of electrical systems.

Recommended prior knowledge:

Basics in mathematics and automation, mastery of computer tools, in particularthe MATLAB software environment and simulation using its Simulink simulation tool.

Material content:

TP No. 1:modeling and simulation of passive and active electrical circuits using state equations and transfer functions. (02 Weeks)

TP No. 2: Modeling and simulation of electromechanical converters. (02 Weeks)

Practical work no. 3:identification of electrical systems by input/output observations and validation of a structure (applications: electric machine, electric oven). **(02 Weeks)**

TP No. 4: Direct measurement of the response of an electrical system and by SBPA generation**(02 Weeks)**

TP No. 5: Parametric identification of an electrical system using the Strejc and Broida Methods. **(02 Weeks)**

TP No. 6: Digital identification (online) of a DC Machine by the Recursive Least Squares Method MCR.**(02 Weeks)**

TP No. 7: Digital identification (online) of an AC Machine by the Recursive Least Squares Method MCR**(02 Weeks)**

Evaluation method:

Continuous control: 100%

Bibliographic references:

1. ID Landau, “Identification of systems”, Hermès, 1998.
2. E. Duflos, Ph. Vanheeghe, “Estimation Prediction”, Technip, 2000.
3. T. Soderstrom, P. Stoica, "System Identification", Prentice Hall, 1989.
4. R. Hanus, “Identification with automaticity”, DE Boeck, 2001.
5. L. Lennart, "System Identification: Theory for the User", Second edition, Prentice Hall 1999.
6. P. Borne, Geneviève Dauphin-Tanguy, Jean-Pierre Richard, "Process modeling and identification", Technip, 1992.
7. R. Ben Abdenour, P. Borne, M. Ksouri, M. Sahli, “Identification and digital control of industrial processes”, Technip, 2001.
8. E. Walter, L. Pronzato, "Identification of Parametric Models from Experimental Data", Springer, 1997.
9. PY-C. Hwang, RG Brown, "Introduction to Random Signals and Applied Kalman Filtering", John Wiley and sons, 1992.

Semester: 2
EU Methodological Code:UEM 1.2

Matter:TP Electrical control techniques
VHS: 37h30 (TP: 2h30)
Credits: 3
Coefficient: 2

Teaching objectives:

- Build schematic simulation models (system blocks) of asynchronous and synchronous direct and alternating current machine controls in the Matlab/Simulink software environment.
- Size, respecting specifications, the different regulators using appropriate methods.
- Simulate control systems for electrical machines, visualize the different quantities and evaluate performance in terms of tracking, regulation and parametric robustness.

Recommended prior knowledge:

Theory of electrical machine control, Matlab/Simulink/SimPower-System software, Static converters, Control and synthesis of regulators, Electrical machines.

Material content:

TP No. 1: Open loop control of the Asynchronous Motor-Inverter association with MLI control. **(02 weeks)**

TP No. 2: Scalar voltage control with converter and PWM control of an asynchronous motor (Regulation with speed loop). (02 weeks)

TP No. 3: Vector control of an asynchronous machine **(03 weeks)**

TP No. 4: Open loop control of the Synchronous Motor-Inverter association with PWM control. **(02 weeks)**

TP No. 5: Vector control of a synchronous machine **(03 weeks)**

TP No. 6:VSdirect torque control (DTC) of an asynchronous/synchronous motor. (03 weeks)

Evaluation method:

Continuous control: 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 Wit, Edition Hermès Sciences, Lavoisier, Paris 2004.

Semester: 2
EU Methodological Code:UEM 1.2
Matter:TP Sampled controls and digital regulation
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

- Model and simulate sampled (discrete) systems;
- Understand sampling and reconstruction;
- Check the dynamic behavior of the sampled (discrete) systems;
- Simulate and implement digital regulators such as PID, RST and digital status feedback.

Recommended prior knowledge:

Know how to use simulation and programming software. Signal processing, control of continuous linear systems.

Material content:

TP No. 1: Simulation of sampling and reconstitution operations **(02 weeks)**

TP No. 2:Time and frequency analysis of basic sampled systems **(02 weeks)**

TP No. 3: Control of electrical systems by digital PI/PID regulator **(02 weeks)**

TP No. 4: Control of electrical systems by digital phase advance/phase delay regulator **(02 weeks)**

TP No. 5:RST type digital control: Case study **(03 weeks)**

TP No. 6: Digital control by status feedback: Application for electrical systems **(02 weeks)**

TP No. 7:Implementation of digital control of an electrical system **(02 weeks)**

Evaluation method:

Continuous control: 100%

Bibliographic references:

1. JR Ragazzini, GF Franklin, Sampled controlled systems, Dunod, 1962.
2. Daniel Viault, Y. Quenec'hdu, Sampled controlled systems, ESE, 1977.
3. E. Godoy, E. Ostertag, Numerical control of systems: Frequency and polynomial approaches, Ellipses Marketing, 2004.
4. H. Buhler, Sampled settings (T1 and T2), PPR.
5. E. Godoy, Industrial Regulation, Dunod.
6. KJ Astrom and B. Wittenmark, Computer controlled systems, Prentice Hall

Semester: 2

EU Methodological Code:UEM 1.2
Matter:TP Diagnosis of control system failures
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Implementthe different knowledge studied in progress for the diagnosis of failures of electrical control systems in order to avoid failures with the aim of improving reliability and continuity of service.

Recommended prior knowledge:

Electrical circuits,machineselectric currents with direct and alternating currents, signal theory, numerical analysis.

Material content:

TP N°1: Fault diagnosis tools for permanent monitoring of an electrical control system **(03 weeks)**

TP No. 2: Diagnosis of control and power equipment **(03 weeks)**

TP No. 3: Vibration analysis of rotating machines with establishment of a technical sheet to be used in maintenance **(03 weeks)**

TPNo.4: Analysis of lubricants for rotating machines with establishment of a technical sheet to be used in maintenance **(03 weeks)**

TP No. 5: Application of intelligent fault diagnosis techniques in cases of multi-symptoms and multi-causes **(03 weeks)**

Evaluation method:

Continuous control: 100%

Bibliographic references:

1. J. Montmain, J. Ragot, D. Sauter, Supervision of complex processes, Lavoisier, 2007.
2. L. Ljung, Systems Identification: theory for the User. Prentice-Hall, 2nd edition, 1999.
3. PSR Murty, Power System Analysis, BS Publications, 2007.
4. D. Brown, D. Harrold, R. Hope, Control System Power and Grounding Better Practice, Elsevier, 2004.
5. G. Cullman, Elements of Informational Computing, Electrical-Mechanical Engineer's Library. Ed. Albin Michel.
6. JD Glover, MS Sama, TJ Overbye, “Power Systems Analysis and Design”, 4th Edition, Thompson-Engineering.

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 two discovery subjects offered on the repository or to choose other discovery subjects among those offered according to the 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,

Evaluation method:

Review: 100%

Bibliographic references:

1. Charter of university ethics and professional conduct,https://www.mesrs.dz/documents/12221/26200/Charte+fran__ais+d__f.pdf/50d6de61-aabd-4829-84b3-8302b790bdce
2. Orders No. 933 of July 28, 2016 setting the rules relating to the prevention and fight against plagiarism
3. The ABCs of Copyright, United Nations Educational, Scientific and Cultural Organization (UNESCO)
4. E. Prairat, On teaching ethics. Paris, PUF, 2009.
5. Racine L., Legault GA, Bégin, L., Ethics and engineering, Montreal, McGraw Hill, 1991.
6. Siroux, D., Deontology: Dictionary of Ethics and Moral Philosophy, Paris, Quadrige, 2004, p. 474-477.
7. Medina Y., Ethics, what will change in the company, Editions d'Organisation, 2003.
8. Didier Ch., Thinking about the ethics of engineers, Presses Universitaires de France, 2008.
9. Gavarini L. and Ottavi D., Editorial. of professional ethics in training and research, Research and training, 52 | 2006, 5-11.
10. Caré C., Morality, ethics, deontology. Administration and education, 2nd quarter 2002, n°94.
11. Jacquet-Francillon, François. Concept: professional ethics. The telemaque, May 2000, n° 17
12. Carr, D. Professionalism and Ethics in Teaching. New York, NY Routledge. 2000.
13. Galloux, JC, Industrial property law. Dalloz 2003.
14. Wagret F. and JM., Patent of invention, trademarks and industrial property. PUF 2001
15. Dekermadec, Y., Innovating through patents: a revolution with the internet. INSEP 1999
16. AEUTBM. The engineer at the heart of innovation. Belfort-Montbéliard University of Technology
17. Fanny Rinck etléda Mansour, literacy in the digital age: copying and pasting among students, University of Grenoble 3 and University of Paris-Ouest Nanterre la Défense Nanterre, France
18. Didier DUGUEST IEMN, Cite your sources, IAE Nantes 2008
19. Similarity detection software: a solution to electronic plagiarism? Report of the Working Group on Electronic Plagiarism presented to the CREPUQ Subcommittee on Pedagogy and ICT
20. EmanuelaChiriac, Monique Filiatrault and André Régimbald, Student guide: intellectual integrity plagiarism, cheating and fraud… avoiding them and, above all, how to properly cite your sources, 2014.
21. Publication of the University of Montreal, Plagiarism prevention strategies, Integrity, fraud and plagiarism, 2010.
22. Pierrick Malissard, Intellectual property: origin and evolution, 2010.
23. The website of the World Intellectual Property Organizationwww.wipo.int
24. http://www.app.asso.fr/

V - Detailed program by subject of the S3 semesters

Semester: 3
EU Fundamental Code:UEF 2.1.1
Subject: Nonlinear and advanced control
VHS: 67h30h (Class: 3h, Tutorial: 1h30)
Credits:6
Coefficient:3

Teaching objectives:

Know the different approaches for modeling and regulating nonlinear systems.
Know the principle of optimal, adaptive, sliding mode controls and differentiate them from other controls. Summary of optimal, adaptive controls by sliding mode. Know the conditions for their application. Application of these commands to industrial processes requiring these types of commands.

Recommended prior knowledge:

- ✓ Control of continuous linear systems;
- ✓ Modeling and control in state space;
- ✓ Mathematical tools (ordinary differential equations, derivative and hook);
- ✓ Systems control and optimization.

Material content:

Chapter 1. Basics of nonlinear systems (03 weeks)
1.1. General information on nonlinear systems, usual nonlinearities and modeling in the state space of nonlinear systems
1.2. Complex interconnected nonlinear systems, singular disturbances.
1.3. Piecewise linear systems (piece-wiselinearsystems) and multi-models

Chapter 2.Stability and control of nonlinear systems (03 weeks)
2.1.Stability, Stability in the sense of Lyapunov.
2.2. Regulation by linearizing state feedback. Input/state linearization.
2.3. Regulation by linearizing state feedback. Input/output linearization.

Chapter 3.Optimal order (03 weeks)
3.1. Formulation of the order problem
3.2. Optimal control of systems in the absence of inequality constraints
3.2.1) Optimal control of a nonlinear and nonstationary system
3.2.2) Optimal control of a linear and non-stationary system with quadratic criterion
3.2.3) Optimal control of a stationary linear system with quadratic criterion (LQ)
3.2.3) Optimal control of a stationary linear system with quadratic criterion (LQG)

Chapter 4.Adaptive control (03 weeks)
4.1. Principle of adaptive control
4.2. The different adaptive control techniques
4.3. Summary of adaptive control laws
4. 3.1. Calculation of direct adaptive control with reference model
4.3.2. Calculation of self-adjusting indirect adaptive control
4.3.3. Calculation of self-adjusting adaptive control with predictor reparameterization

Chapter 5.Advanced control techniques **(03 weeks)**

5.1.Control by sliding mode
5.2. Ordered by Backstepping.
5.3. Passivity-based control.

Evaluation method:

Continuous monitoring: 40%; Review:60%.

Bibliographic references:

1. M. Vidyasagar, Nonlinear system analysis, Prentice Hall
2. A. Isidori, Nonlinear control systems (I and II), Springer-Verlag
3. HK Khalil, Nonlinear Systems, Prentice Hall
4. H. Nijmeijer, Nonlinear dynamical control systems
5. D. Alazar, "Robustness and optimal control". Masson 1990
6. R. Boudarel et al., "Optimal process control". Masson 1989
7.JP. Babary and W. Pelczewski, "Optimal control of deterministic continuous systems". Masson 1985
8. SN Desineni, "Optimal control system". CRC Press 2003
9. R. Lozano and D. Taoutaou, "Adaptive control and applications". Paris: Hermès Science Publications, 2001
10. P. Naslin, 'Control theory and optimal conduct, Dunod 1969
11.JP. Babary and W. Pelczewski, "Optimal control of deterministic continuous systems". Masson 1985.
11. K. Astrom, B. Wittenmak, 'Adaptive Control' Lund Institute of Technology, Addison Wisly Publishing Company 1989
12. Grellet, 'Electric actuators' Eyrolles, 1999
13. J. Levine, 'Introduction to nonlinear control' Center for Automation and Systems. Paris mining school
14. J. Levine, 'Analysis and Control of Nonlinear Systems',
Automation and Systems Center. Paris mining school
15. NadjibBennis, 'State representation of continuous linear systems, control by placement of poles',
16.www.specialautom.net

Semester: 3
Fundamental EU Code: 2.1.1
Subject: Programmable controllers
VHS: 10:30 p.m.(Class: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives

It first involves acquiring the skills necessary to design (Hardware and software) an automation solution based on an API, then delving deeper into designing and implementing a digital control (for the regulation of speed of a motor for example). Deal with some industrial applications and consider the more or less complex forms of GRAFCET, and introduce yourself to industrial networks.

Recommended prior knowledge

Combinatorial and sequential logic, programming, microprocessor.

Content of the subject

Chapter 1: General architecture of a PLC, Hardware description of the Simatic S7-? (such as S7-200/ CPU216)(I/O, concept of cycle, data types and addressing modes, etc.),

Chapter 2: Instruction game, basic (step 7 language)(Logic stack, Boolean instructions, transfer instructions, arithmetic and logic instructions),

Chapter 3: Timers(identification and programming),

Chapter 4: Interruptions(Organization of a program/step-7, S7-? events (the S7-200 for example), handling of an interrupt event, programming),

Chapter 5: Analog I/O(identification and programming)

Chapter 6: PID control loop(identification and programming)

Chapter 7: Industrial Networks(General architecture, communication protocols, Application)

Evaluation mode

Exam:100%.

Bibliographic references

1. Micro System SIMATIC S7-200 One Hour Primer, Siemens AG 1999
2. Micro System SIMATIC S7-200 Two Hour Primer, Siemens AG 2000
3. SIMATIC S7-200 Programmable Controller System Manual, Siemens AG 1998
4. E. Godoy, Industrial regulation: Modeling tools, methods and control architectures, 2nd edition. Paris: Dunod, 2014.
5. K. Kamel and E. Kamel, Programmable Logic Controllers: Industrial Control. New York: McGraw-Hill Professional, 2013.
6. W. Bolton, Industrial programmable logic controllers. Paris: Dunod, 2010.
7. J. Stenerson, Programmable Logic Controllers with Controllogix, International Edition. Clifton Park, NY: Broadman & Holman Publishers, 2009.
8. S. Moreno and E. Peulot, Le Grafcet: Design-Implementation in industrial programmable logic controllers. Saint-Quentin-en-Yvelines: Casteilla, 2009.
9. FP Miller, AF Vandome, and J. McBrewster, Industrial Programmable Logic Controller: Computer programming, Automatic, Industry, Program (computer science), Switch, Automatic engineer. AlphascriptPublishing, 2010.

Semester: 3

EU Fundamental Code:UEF2.1.2
Subject: I techniquesartificial intelligence
VHS: 45h (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Allow the student to become familiar with artificial intelligence techniques applied to the field of system control and optimization

Recommended prior knowledge:

Dynamic systems, notions of mathematical analysis, notions of optimization, notions of probability.

Content of the material:

Chapter 1 : Fuzzy logic (02 weeks)

General basics. Fuzzy sets. Linguistic variables. Membership function. Fuzzy logic operators. General structure of a fuzzy control. Fuzzification. Inference engine or decision block. Inference methods. Defuzzification.

Chapter 2 : Neural networks (03 weeks)

Topology of neural networks. Layered networks. Static networks. Dynamic neural networks. Learning neural networks. Supervised and unsupervised learning.

Chapter 3: Neuro-fuzzy networks (02 weeks)
Chapter 4: Genetic algorithms (02 weeks)
Chapter 5: Particle swarm optimization technique (02 weeks)
Chapter 6: Expert systems (02 weeks)
Chapter 7: Probability and probabilistic reasoning (02 weeks)

Evaluation method:

Continuous control: 40%; Exam: 60%.

Bibliographic references:

1. PA Bisgambiglia, Fuzzy logic and its applications, Hermès-science
2. H. Buhler, Fuzzy logic control, PPR
3. HeikkiKoivo, Soft computing
4. DR Hush & BG Horne,"Progress in Supervised Learning Neural Networks," IEEE signal proc. magazine, Vol.10, No.1, pp.839, Jan. 1993.
5. B. Kosko, "Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence," Englewood Cliffs, NJ: Prentice-Hall, 1992.
6. LX Wang, "Adaptive Fuzzy Systems & Control: Design & Stability Analysis": Prentice-Hall, 1994.
7. David E. Goldberg, Genetic Algorithms, Edit. Addison Wesley, 1994.
8. *HansruediBühler,"Adjustment by fuzzy logic"*
9. *Pierre-yvesGlorennec, "Learning algorithms for fuzzy inference systems"*
10. *P. Borne, J. Rozinoer, J.-Y. Dieulot, L. Dubois, "Introduction to fuzzy control"*
11. *Bernadette Bouchon-Meunier, Laurent FOULLOY, MOHAMMED RAMDANI, "Fuzzy logic. Corrected exercises and application examples »*

12. *BERNADETTE BOUCHON-MEUNIER, "Fuzzy logic and its applications"*
13. *Hung T. NguyenNadipuram R. Prasad, Carol L. Walker • Elbert A. Walker, "A First Course in Fuzzy and Neural Control"*
14. *FAKHREDDINE O. KARRAY, CLARENCE DE SILVA,"Soft computing and intelligent systems design. Theory, tools and applications »*
15. *ROCK. BORNE, MOHAMED BENREJEB, JOSEPH HAGGÈGE, "Neural networks. Presentation and applications »*
16. *BEGHDADI HADJ ALI, SENOUCI MOHAMED, "Neural networks: Theory and practice"*
17. *G. DREYFUS, J. –M. MARTINEZ, M. SAMUELIDES, MB GORDON, F. BADRAN, S. THIRIA, L. HÉRAULT, "Neural networks. Methodology and applications »*
18. *LÉON PERSONNAZ, ISABELLE RIVALS,"Formal neural networks for modeling, control and classification"*
19. *CHRISTINE SOLNON, "Optimization by ant colonies"*
20. *NICOLAS MONMARCHÉ, FRÉDÉRIC GUINAND, PATRICK SIARRY"Artificial ants 1. From the basics of optimization to industrial applications"*
21. *STUART RUSSELL, PETER NORVIG, "Artificial intelligence, with more than 500 exercises"*
22. *JOHANN DRÉO, ALAIN PÉTROWSKI, PATRICK SIARRY, ÉRIC TAILLARD, "Metaheuristics for hard optimization: Simulated annealing, search with taboos, evolutionary algorithms and genetic algorithms, ant colonies…"*
23. *PATRICK SIARRY ET ALL, "Metaheuristics: Simulated annealing, taboo search, variable neighborhood search, GRASP methods, evolutionary algorithms, artificial ants, particle swarms and other optimization methods"*

Semester: 3
EU Fundamental Code:UEF2.1.2
Matter :Electrical control of industrial mechanisms

VHS: 67h30 (Class: 3h00, tutorial 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:

Prepare the student for better integration into industry by presenting the different industrial mechanisms as well as appropriate control techniques.

Recommended prior knowledge:

Basic principles of control, electromechanical systems

Content of the material:

Chapter 1: Criteria for choosing an electric motor in an industrial environment (02 weeks)

1.1 -Electric motors

Motors for bridges, Motors of specific construction, Use of electrical machines of normal construction

1.2- Choice of engines:

According to the power, the operating speed

Chapter 2: Electrical control and automation of pumps, fans and compressors (03 weeks)

General principles, Power at the end of the shaft, Starting of fan torque mechanisms, Electrical control of fans, General recommendation for the choice of electrical control of pumps, fans and compressors.

Chapter 3: Power supply and automation of elevators and extractors (02 weeks)

General principles, Parking accuracy of lifting systems, Requirements in elevator control systems, Typical control diagrams for elevators, Automation of elevator speed controls.

Chapter 4: Automation of overhead cranes (02 weeks)

General principles, Motor loads of overhead crane mechanisms, Electromagnetic lifting systems, Electrical control systems of overhead cranes, Requirements for the mechanical characteristics of electric controls of overhead cranes, Automation of overhead cranes using thyristor converters, Equipment of overhead cranes large overhead cranes, Remote control of overhead cranes, Power supply of overhead cranes.

Chapter 5: Power supply and automation of continuous transport mechanisms (03 weeks)

General principles, Choice of conveyor control, Matching the rotation of several conveyor motors, Electrical control of transport systems

5-5-Power supply and automation of a cable car, Transport machines for the movement of passengers (traction): Escalators, Elevators with several cabins, Rotor excavator;

Chapter 6: Mini-projects: (03 weeks)

Case study(excavators, rolling mills, electric furnaces, welding equipment, electrolysis and coating of metals, metallurgical plants, chemical industry, oil drilling station, paper and cellulose industry, cement industry, industry glass and metal industry etc.).

Evaluation method:

Continuous control: 40%; Exam: 60%.

Semester: 3
EU Methodological Code:UEM 2.1
Subject: TP non-linear and advanced control
VHS: 10:30 p.m. (TP: 3:00 a.m.)
Credits:4
Coefficient:2

Teaching objectives:

Allow the student to have all the necessary tools to program, simulate, validate and implement the different approaches for the modeling and regulation of nonlinear systems as well as the validation of optimal, adaptive controls, and other advanced techniques to know Sliding mode, Backstepping or Passivity by simulation. Then, implementation on a test bench equipped with a DsPace control card and acquisition cards

Recommended prior knowledge:

Systems control and optimization. Programming as well as knowing how to use programming and simulation software for dynamic systems (Matlab).

Content of the material:

TP 1: Usual nonlinear systems, interconnected complexes, singular disturbances. (02 weeks)
TP 2: Regulation by linearizing state feedback. Input/output linearization. (02 weeks)
TP 3: Validation by simulation with Matlab of an optimal control without constraints of a direct current motor then Validation on a test bench equipped with DsPACE. (02 week)
TP 4: Validation by simulation with Matlab of a direct adaptive control with a reference model of a direct current motor, as well as validation on a test bench equipped with DsPACE. (02 week)
TP 5: Validation by simulation with Matlab of a sliding mode control of a DC motor as well as validation on a test strip equipped with DsPACE. (02 week)
TP 6: Validation by simulation with Matlab of a command by Backstepping. (02 week)
TP 7: Validation by simulation with Matlab of a control based on passivity. (02 week)

Evaluation method:

Continuous control: 100%

Bibliographic references:

1. R. Lozano and D. Taoutaou, "Adaptive control and applications". Paris: Hermès Science Publications, 2001.
2. D. Alazar, "Robustness and optimal control". Masson 1990.
3. R. Boudarel et al., "Optimal process control". Masson 1989.
4. JP. Babary and W. Pelczewski, "Optimal control of deterministic continuous systems". Masson 1985.
5. SN Desineni, "Optimal control system". CRC Press 2003.
6. VI Utkin, "Sliding mode and their application in variable structure system". Mir, Moscow 1978.
7. H. Buhler, "Adjustment by sliding mode". Presse polytechnique romandes, Lausanne, 1983.
8. M. Vidyasagar, Nonlinear system analysis, Prentice Hall
9. A. Isidori, Nonlinear control systems (I and II), Springer-Verlag
10. HK Khalil, NonlinearSystems, Prentice Hall
11. H. Nijmeijer, Nonlineardynamical control systems
12. J. Levin, Analysis and control of nonlinear systems

Semester: 3
EU Methodological Code:UEM 2.1
Matter:TP Artificial intelligence techniques/ TP Implementation of real-time digital control
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Program and simulate control laws based on artificial intelligence techniques.
Know how to implement a digital control in real time.

Recommended prior knowledge:

Simulation and programming software. Dynamic systems. Optimization. The logic. The probabilities.

Content of the material:

Practical work in artificial intelligence techniques

TP 1: Introduction to fuzzy logic. (01 weeks)
TP 2: Artificial neural networks. (01 weeks)
TP 3: Adaptive networks and neuro-fuzzy networks. (01 weeks)
TP 4: Genetic algorithms.(02 weeks)
TP 5:PSO.(01 weeks)
TP 6: Expert systems and probabilistic reasoning. (02 weeks)

TP Implementation of real-time digital control

TP 1: Modeling and Implementation of a CAN Analog-to-Digital Converter "under Matlab" **(01 weeks)**
TP 2: Modeling and Implementation of a DAC Digital Analog Converter "under Matlab" **(01 weeks)**
TP 3: Speed regulation of a DC motor by digital PID (01 weeks)
TP 4: Implementation of MLI techniques on a digital processor (02 weeks)
TP 5: Control of an electric motor by computer (02 weeks)

Evaluation method:

Continuous control: 100%

Bibliographic references:

1. PA Bisgambiglia, Fuzzy logic and its applications, Hermès-science
2. H. Buhler, Fuzzy logic control, PPR
3. HeikkiKoivo, Soft computing
4. DR Hush & BG Horne,"Progress in Supervised Learning Neural Networks," IEEE signal proc. magazine, Vol.10, No.1, pp.839, Jan. 1993.
5. B. Kosko, "Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence," Englewood Cliffs, NJ: Prentice-Hall, 1992.
6. LX Wang, "Adaptive Fuzzy Systems & Control: Design & Stability Analysis": Prentice-Hall, 1994.
7. David E. Goldberg, Genetic Algorithms, Edit. Addison Wesley, 1994.

Semester: 3
EU Methodological Code:UEM 2.1
MatterTP: Electrical control of industrial mechanisms
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Learn from real order examples

Recommended prior knowledge:

Control technology, electromechanical systems.

Content of the material:

TP 1: Automatic barrier (02 weeks)
TP 2: Piercing(02 weeks)
TP 3: Soap marking (02 weeks)
TP 4: Door system(03 weeks)
TP 5: Freight lift (03 weeks)
TP 6: Sorting bricks (03 weeks)

Evaluation method:

Continuous control: 100%

Bibliographic references:

TP brochures

Semester: 3
EU Methodological Code:UEM 2.1
Matter:Programmable automation TPindustrial (API)
VHS: 3 p.m. (TP: 1 hour)
Credits: 1
Coefficient: 1

Teaching objectives

Teach the student how to install, program and use a PLC. Introduce them to mastering the tasks of editing and debugging programs as well as correcting detected errors.
Synthesis, simulation and implementation of systems based on a PLC (logical automation, servocontrols and industrial networks)

Recommended prior knowledge

Combinatorial and sequential logic, API, GRAFCET, step7, Simatic S7.

Content of the subject

TP 1: A logical automatism: pneumatic cylinder system,

TP 2: A logical automatism: system with various logical processes: motors, cylinders, etc.; with direct or timed actions; with emergency events (interrupt support),

TP 3: Enslavement: implementation and simulation and/or creation of a control for an electric motor,

TP 4: Industrial Network: implementation and operation of an industrial network,

Noticed :

The above practical tasks can be carried out on the software platform (TIA Portal); or experimental (a test bench based on a Simatic S7-? such as the S7-200) with reduced-scale processes (small motors, small cylinders), displays, tachometers, buttons, etc.

Evaluation mode

Continuous monitoring:100%

Bibliographic references

1. Micro System SIMATIC S7-200 One Hour Primer, Siemens AG 1999
2. Micro System SIMATIC S7-200 Two Hour Primer, Siemens AG 2000
3. SIMATIC S7-200 Programmable Controller System Manual, Siemens AG 1998
4. JA Rehg and GJ Sartori, Programmable Logic Controllers, 2nd ed. Upper Saddle River, NJ: Prentice Hall, 2008.
5. EP Adrover, Introduction to PLCs: A beginner's guide to Programmable Logic Controllers. San Bernardino, CA: Elvin Perez Adrover, 2012.
6. JR Hackworth and FDH Jr, Programmable Logic Controllers: Programming Methods and Applications, 1st ed. Upper Saddle River, NJ: Prentice Hall, 2003.
7. G. Barton, programmable logic controller 139 Success Secrets - 139 Most Asked Questions On programmable logic controller - What You Need To Know. Emereo Publishing, 2014.
8. RJ Tocci, N. Widmer, and G. Moss, Digital Systems: Principles and Applications: International Edition, 11th ed. Boston, Mass.: Pearson, 2010.

Semester: 3
Teaching unit: UED 2.1
Matter :Subject 5 to choose from
VHS: 10:30 p.m. (class: 1h30)
Credits: 1
Coefficient: 1

Semester: 2
Teaching unit: UED 2.1
Matter :Subject 6 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 two discovery subjects offered on the repository or to choose other discovery subjects among those offered according to the needs and interest of the training..

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 and 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 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 (QEE), 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: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 familiarize themselves 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.

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:

None

Content of the material:

Chapter 1 : Birth and evolution of the concept of industrial ecology**(02 weeks)**

Chapter 2 : Definition and principles of industrial ecology**(02 weeks)**

Chapter 3: Industrial ecology experiences in Algeria and around the world**(02 weeks)**

Chapter 4: Industrial symbiosis (eco-industrial parks/networks)**(03 weeks)**

Chapter 5: Gaseous, liquid and solid waste**(03 weeks)**

Chapter 6: Recycling**(03 weeks)**

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 sensors associated 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 **(04 weeks)**

Chapter 2 : Solar energy (photovoltaic and thermal) **(04 weeks)**

Chapter 3: Wind power **(03 weeks)**

Chapter 4: Other renewable sources: hydraulic, geothermal, biomass, etc. (02 weeks)

Chapter 5: Storage, fuel cells and hydrogen **(02 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 DiscoveryCode: UED..
Matter:Maintenance and operational safety
VHS:10:30 p.m.(Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Recommended prior knowledge:

Content of the subject

VSchapter 1:History, context and definitions of SdF (02 weeks)

VSchapter 2:Analysis of independent component systems (02 weeks)

Modeling of the malfunction logic by fault trees, qualitative and quantitative Boolean exploitation, limits of the method.

VSchapter 3:Analysis of systems taking into account certain dependencies (03 weeks)

Modeling of systems, Markovian by state graphs, Quantitative exploitation of the model, Limit of the method

VSchapter 4:Analysis of systems with generalized consideration of dependencies (03 weeks)

Modeling using petrie networks (RdP), Quantitative exploitation of the model: RdP: stochastic

VSchapter 5:Application of operational safety methodologies (03 weeks)

Reliability, Maintainability, Availability, Security.

VSchapter 6:Reliability forecast methodology (02 weeks)

Reliability forecast calculation, Failure mode analysis, 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

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.

Semester: ..
EU Discovery Code:UED...
Subject: Special machines

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

Teaching objectives:

At the end of this training, the student will increase his training by acquiring new skills due to the evolution of the field in which he already has training, enrich his culture and his knowledge on the different types of electrical machines.

Recommended prior knowledge:

Electrical machines, construction of electrical machines, electromagnetic conversion.

Content of the material:

Chapter 1 :Introduction to special machines(01 weeks)
Chapter 2 :Asynchronous machines(04 weeks)

- ✓ Single-phase motor
- ✓ Linear motor

Chapter 3:Synchronous Machines(05 weeks)

- ✓ Synchromachines
- ✓ Variable reluctance machine
- ✓ Permanent magnet motors
- ✓ Stepper motors
- ✓ Superconducting machines

Chapter 4:Micromachines(05 weeks)

- ✓ Synchromachines (Selsynes)
- ✓ Hysteresis synchronous motors
- ✓ DC tachogenerators
- ✓ Resolvers

Evaluation method:

Review: 100%.

Bibliographic references:

1. M. Kostenko and L. Piotrovsky, Electrical machines
2. Real-Paul BOUCHARD and Guy OLIVIER, Design of asynchronous motors
3. B.Saint –Jean, Electrotechnics and electrical machines

Semester: ..
Master: Electrical Control
EU Discovery Code:UED

Subject: Transient regime of electrical systems
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

To size electrical system protection devices, the study of transient regimes is essential. This course therefore focuses on the study of transient regimes of electrical machines. The dynamic behaviors of electrical machines are treated both in linear regime and in nonlinear regime (where the notion of extension of linear models to the saturated regime is introduced).

Recommended prior knowledge:

Electrical circuits, electrical machines, Modeling of machines. Power electronics.

Material content:

I. Dynamic model of the asynchronous machine(6 weeks)
- Reminders on relative and symmetrical components
- Analysis of transient regimes of asynchronous machines
- Motor operation
- Generator operation
- Dynamic performance during the three-phase fault of the asynchronous machine

II. Dynamic model of the synchronous machine(5 weeks)
- Analysis of transient regimes of synchronous machines
- Alternator operation
- Engine operation
- Dynamic performance during the three-phase fault of the asynchronous machine

III. Dynamic model of the DC machine (4 weeks)
- Analysis of transient conditions of the machine
- Generator operation
- Motor operation

Evaluation method:

Review: 100%.

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

Teaching objectives:

- Understand, in terms of control and command, automated industrial systems;
- Learn the methodology for studying automated systems;
- Development of specifications;
- Carry out programming and configuration of programmable controllers;
- Be able to implement industrial systems designed around programmable industrial controllers.

Recommended prior knowledge:

Combinatorial and sequential logic, electrical diagrams and equipment, industrial technologies

Material content:

Chapter I: Industrial programmable controllers (4 weeks)
Basic notions, Overall function of an automated system, Production system, Automation, Structure of an automated production system (SAP), Hardware architecture of APIs, Criteria for choosing an API, Summary of sequential systems, Methods of analyzes of the operation of automated systems
Chapter II: Grafcet tool (6 weeks)
Fundamental notions, Basic concepts, Basic principle, Rules of evolution, Basic structures, Concept of Sequence, Special structures, Advanced notions, Hierarchical structure of a grafcet, Forcing and freezing of situations, is in equation of a grafcet
Chapter III: Languages and API programming (5 weeks)
Common objects, Different types of languages, SFC language, LD language, IL language, FBD language, ST language, LADDER language (LD), LADDER symbolism, Implementation of API-based automation

Evaluation method:

Review: 100%.

Semester : ..
Master: Electrical Control
EU Discovery Code:UED
Matter:Industrial automation and IT
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Understand the operation and architecture of automated systems and the contribution of industrial computing to them.

Recommended prior knowledge:

Algorithms, programming, circuits and electrical systems.

Material content:

Part 1

1. Structure of an automated system: relations part; control part; operational part
2. Examples of automated systems: Heating box; Brightness box; Home automation model…etc.
3. Modbus communication protocol: Transfer via Ethernet; Modbus frames, Example of exchange between a master and a slave
4. Programming languages for automation applications:
4.1. Textual language: IL "instruction list", or list of instructions (ASSEMBLER example); ST "structuredtext" or structured text (Matlab example);
4.2. Graphical language: FBD "function block diagram", or block diagram (Example: Crouzet Millenium 3); LD "ladderdiagram", or ladder diagram: programming of Boolean equations (true/false); SFC "sequentialfunction chart": GRAFCET example, and all sequential processes.

Part 2

1.Presentation of industrial computing and micro-programmed systems
2.Microcontroller architecture
3. Presentation of the different elements of a micro-controller, elements of choice
4.Reminders about binary numbers and the different codings
5.Instructions
6. Reminders on combinatorial and sequential logic
7.Study of the operation of a microcontroller: the PIC 18F4520
8.Assembler programming -- Reminder on algorigrams
9.Interrupt overview
10. Study of an Assembler program with interrupt management
11. Presentation of functions integrated into the microcontroller (timer, PWM, etc.)
12. Presentation of the C language for the microcontroller / specificity for the PIC 18F4520

Evaluation method:

Review: 100%.

Bibliographic references:

1. Michel Lauzier,Gerard Colombari" Automatic and informatic industrial. Volume 1, Tools of description", 96p, Foucher, 1994.
2. Michel Lauzier,Gerard Colombari" Automatic and informatic industrial. Volume 2, Systems Design", 128p, Foucher, 1995.
3 Jean Perrin, Francis Binet, JJ Dumery, Christian Merlaud, JP Trichard "Automation and industrial computing, theoretical, methodological and technical bases", 336p,NATHAN (November 12, 2004).
4. Jean-Louis Fanchon, JM Bleux "Industrial automation", 128p, NATHAN 2001
D Blin, J Danic, R Le Garrec, F Trolez, Jc Seite "Automation and industrial computing",Educalivre August 1, 1999.

Semester : ..
Master: Electrical Control
EU Discovery Code:UED
Matter:Control of future energy systems
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Subject program

1- Reminders on systemsNew and Renewable Energies: General notions, Non-renewable electrical energy, Renewable electrical energy, Micro-grids, Control and monitoring of electrical energy systems, Need for intelligent electrical systems: Smart House, Smart City, Smart Grid , Electric smart meter, Smart grid communication technology (ZigBee, Winmax, other types of communications);
2- Artificial Intelligence in future energy systems: AI for domestic networks (Smart Home); AI for micro-grid balance (Smart City); AI for the global Supply – Demand balance (Smart Grids); AI for Marketplaces and collaborative platforms; AI for predictive maintenance and operations; AI for digital workforces (Digital Workforces)
3- How does AI redefine the issues surrounding energy: With suppliers (producers), customers (Consumers) and intermediaries or facilitators? What will it fundamentally transform in this ecosystem.
4- Artificial intelligence tool for robust optimization of energy production and consumption.
5- Concepts on Big Data (large numbers) and IoT (Internet of Things) platforms for real-time aggregation of heterogeneous data.

Evaluation method:

Review: 100%.

Bibliographic references:

1. C. SABONNADIÈRE and N. HADJSAID – Smart-grids: intelligent electricity networks, HERMES, 2012.

2. N. HADJSAID – Electric distribution networks: from decentralized production to smart grids, HERMES, 2010.

3. BOUCKAERT Stéphanie "Contribution of Smart Grids to the energy transition: evaluation in long-term scenarios". PhD thesis, Ecole Nationale Supérieure des Mines de Paris. 2013. https://pastel. archives-ouvertes.fr/pastel-00959266/document

4. L. Freris and D. Infield, "Renewable energy for electricity production", DUNOD, Paris 2009.

5. BURTON T. SHARPE D. JENKINS N. BOSSANYI E. HASSAN G. "Wind energy Handbook", England, 2001.

6. Riolet E., Solar and photovoltaic energy for individuals, Eyrolles, 2010.

7.Bryans L., Flynn D., Fox B. et al, Wind electrical energy, Dunod, 2015.

8.Damien A., Biomass energy, Dunod, 2013.

9.Ginocchio R., Viollet P.-L., Hydraulic Energy, Lavoisier, 2012.

10."The value chain of the smart grid market", www.items.fr. 2012.

11. Smart Grids-cre, "Advanced meters" file, http://www.smartgridscre.fr/index.php.

12.ZigBee homepage. onhttp://www.zigbee.org

13.SmartGrids – CRE, "Smart Grid City: local management of sources of supply and consumption", 2011, available on:http://www.smartgrids-cre.fr/index.php?p=smartcities-smart-grid-city

14.Chambolle.T, Meaux.F, 'Report on new energy technologies', Paris 2004.

15. Frédéric Scibetta, Yvon Moysan, Eric Dosquet, Frédéric Dosquet"The Internet of Things and data: Artificial intelligence as a strategic breakthrough", DUNOD,**2018.**

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. Wit, Edition Hermès Sciences, Lavoisier, Paris**2004**.