People's Democratic Republic of Algeria الجمهورية الجزائرية الديمقراطية الشعبية

وزارة التعليم العالي والبحث العلمي

Ministry of Higher Education and Scientific Research

اللجنة البيداغوجية الوطنية لميدان العلوم و التكنولوجيا

National Pedagogical Committee of the Science and Technology field

HARMONIZATION

TRAINING OFFER

ACADEMIC MASTER's DEGREE

National Program
Update 2025

Domain	Spinneret	Speciality
Sciences and Technologies	***Electrotechnical***	***Power Grids***

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نموذج مطابقة

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ماستر أكاديمية

تـحديـث 2025

الميدان	الفرع	التخصص
علوم و تكنولوجيا	كهروتقني	شبكات كهربائية

I – Master's identity sheet

Conditions of access

(Indicate the bachelor's specialties that can give access to the Master's degree)

Spinneret	Harmonized Master's Degree	Access Licenses Master's degree	Classification according to license compatibility	Coefficient assigned to the licence
Electrotechnical	Power Grids	Electrotechnical	**1**	**1.00**
		Electronic	**3**	**0.70**
		Automatic	**3**	**0.70**
		Other ST Domain Licenses	**5**	**0.60**

II – Semester organisation sheets for teaching of the specialty

Semester 1 Master's Degree: Power Networks

Teaching unit	Materials	Credits	Coefficient	Weekly hourly volume			Semi-Annual Hourly Volume (15 weeks)	Complementary work in Consultation (15 weeks)	Evaluation method	
	Entitled			**Course**	**TD**	**TP**			**Continuous assessment**	**Examination**
Core UE Code: UEF 1.1.1 Credits: 10 Coefficients: 5	Electrical energy transmission and distribution networks	4	2	1h30	1h30		45h00	55:00 pm	40%	60%
	Advanced Power Electronics	4	2	1h30	1h30		45h00	55:00 pm		
	μ-processors and μ-controllers	2	1	1h30			10:30 p.m.	27:30		100%
Core UE Code: UEF 1.1.2 Credits: 8 Coefficients: 4	In-depth electrical machines	4	2	1h30	1h30		45h00	55:00 pm	40%	60%
	Applied numerical methods and optimization	4	2	1h30	1h30		45h00	55:00 pm	40%	60%
Methodological UE Code: EMU 1.1 Credits: 9 Coefficients: 5	TP: - μ-processors and μ-controllers	1	1			1h00	3:00 p.m.	10:00 a.m.	100%	
	TP: - Electrical energy transmission and distribution networks	2	1			1h30	10:30 p.m.	27:30	100%	
	TP: - Advanced Power Electronics	2	1			1h30	10:30 p.m.	27:30	100%	
	Practical work: Applied numerical methods and optimization	2	1			1h30	10:30 p.m.	27:30	100%	
	TP: - in-depth electrical machines	2	1			1h30	10:30 p.m.	27:30	100%	
	Advanced Python Programming	2	2	1h30		1h30	45h00	5h00	40%	60%
Discovery UE Code: UED 1.1 Credits: Coeff.: 1	Basket of your choice	1	1	1h30			22h30	02h30		100%
Semester 1 total		**30**	**17**	**12h00**	**6:00 pm**	**7:30 pm**	**382h30**	**367h30**		

Semester 2 Master's Degree: Electrical Networks

Teaching unit	Materials: Entitled	Credits	Coefficient	Weekly hourly volume: Course	TD	TP	Volume Semester Schedule (15 weeks)	Work Complementary In consultation (15 weeks)	Evaluation method: Continuous assessment	Examination
Core UE Code: UEF 1.2.1 Credits: 10 Coefficients: 5	Modeling and optimization of power grids	4	2	1h30	1h30		45h00	55:00 pm	40%	60%
	Electrical Power Quality	4	2	1h30	1h30		45h00	55:00 pm	40%	60%
	Centralized and decentralized production	2	1	1h30			10:30 p.m.	27:30		100%
Core UE Code: UEF 1.2.2 Credits: 8 Coefficients: 4	Power grid planning	4	2	1h30	1h30		45h00	55:00 pm	40%	60%
	Control of electro-energy systems	4	2	1h30	1h30		45h00	55:00 pm	40%	60%
Methodological UE Code: EMU 1.2 Credits: 9 Coefficients: 5	Techniques for protecting power grids	3	2	1h30		1h00	37:30 p.m.	37:30 p.m.	40%	60%
	TP: Modeling and optimization of electricity networks	2	1			1h30	10:30 p.m.	27:30	100%	
	TP: Electrical Power Quality	2	1			1h30	10:30 p.m.	27:30	100%	
	TP: Control of electro-energy systems	2	1			1h30	10:30 p.m.	27:30	100%	
Transversal UE Code: UET 1.2 Crédits: 3 Coefficients: 3	Elements of Applied Artificial Intelligence.	2	2	1h30	1h30		45h00	05h00	40%	60%
	Ethics, deontology and intellectual property	1	1	1h30			22h00	02:30 am		100%
Semester 2 total		**30**	**17**	**1:30 p.m.**	**6:00 pm**	**5:30 a.m.**	**375h00**	**367h00**		

Semester 3 Master's Degree: Electrical Networks

Teaching unit	Materials: Entitled	Credits	Coefficient	Weekly hourly volume: Course	TD	TP	Semi-Annual Hourly Volume (15 weeks)	Work Complementary In consultation (15 weeks)	Evaluation method: Continuous assessment	Examination
Core UE Code: UEF 2.1.1 Credits: 10 Coefficients: 5	Electricity grid management	4	2	1h30	1h30		45h00	55:00 pm	40%	60%
	Stability and dynamics of power grids	4	2	1h30	1h30		45h00	55:00 pm	40%	60%
	Smart Grids	2	1	1h30			10:30 p.m.	27:30		100%
Core UE Code: UEF 2.1.2 Credits: 8 Coefficients: 4	Integration of renewable resources into electricity grids	4	2	1h30	1h30		45h00	55:00 pm	40%	60%
	Industrial Power Grids	4	2	1h30	1h30		45h00	55:00 pm	40%	60%
Methodological UE Code: EMU 2.1 Credits: 9 Coefficients: 5	High voltage technology	5	3	1h30	1h30	1h00	60:00	65h00	50%	50%
	TP: Stability and Dynamics of Power Grids	2	1			1h30	10:30 p.m.	27:30	100%	
	TP: Industrial power grids	2	1			1h30	10:30 p.m.	27:30	100%	
Transversal UE Code: UET 2.1 Credits: 1 Coefficients: 1	Reverse Engineering	2	2	01h30	1h 30 Workshop		45h00	5h00	40%	60%
	Literature search and memory design	1	1	1h30			10:30 p.m.	02:30 am		100%
Semester 3 total		**30**	**17**	**1:30 p.m.**	**7:30 a.m.**	**4:00 pm**	**375h00**	**375h00**		

Discovery UE *(S1, S2 and S3)*

1- Renewable
2- Industrial IT
3- Electromagnetic compatibility
4- Maintenance and Operational Safety
5- Implementation of real-time numerical control
6- Electrical engineering materials and their applications
7- Artificial intelligence techniques
8- Propagation of electrical waves on the energy network
9- Introduction to Software Engineering
10- Industrial Ecology and Sustainable Development
11- Maintenance of electrical networks
12- Embedded Electrical Networks
13- Electrical Energy and Buildings
14- High Voltage Electrical Equipment
15- Other...

Semester 4

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

	VHS	Coeff	Credits
Personal work	550	09	18
Internship in a 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 Master's End of Cycle Project

- Scientific value (Jury's assessment) /6
- Writing of the Thesis (Jury's Assessment) /4
- Presentation and answer to questions (Jury's assessment) /4
- Supervisor's assessment /3
- Presentation of the internship report (Jury's assessment) /3

III - Detailed programme by subject of the S1 semester

Semester: 1
UE Fundamental Code: UEF 1.1.1
Subject: Electrical energy transmission and distribution networks
VHS: 45h (Lecture: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The objective of this course can be divided into two: on the one hand, to broaden the knowledge acquired during the Bachelor's Degree course 'Power Grids', and on the other hand, to introduce the necessary knowledge about the management and operation of power systems.

Recommended prior knowledge:

Fundamental laws of electrical engineering (Ohm's Law, Kirchhoff's Laws, etc.), Analysis of alternating current electrical circuits, complex calculation. Modeling of power lines (Electrical networks course in Bachelor's degree).

Material content:

Chapter 1. Substation Architectures (2 weeks)

Global architecture of the electrical network, equipment and substation architecture (busbar-coupled substations, circuit breaker-coupled substations), topologies of energy transmission and distribution networks.

Chapter 2. Organization of the transmission of electrical energy

2.1. Power transmission lines (3 weeks)

Calculation of transmission lines: Choice of conductor cross-section, insulation, mechanical calculation of lines, Operation of transmission lines in a steady state. Transient operation of transmission lines. Direct current power transmission (HVDC).

2.2. Distribution networks (2 weeks)

Introduction to electrical power distribution, primary distribution, secondary distribution, distribution transformers, reactive energy compensation in distribution networks, distribution reliability.

Chapter 3. MV and LV power grid operation (3 weeks)

Protection of HV/MV substations against overcurrent and overvoltage). Models of the elements of the electrical network. Voltage Adjustment, Voltage Adjustment Devices, - Reactive Power Control on an Electrical System

Chapter 4. Neutral Regimes (2 weeks)

The regimes of neutral (isolated, grounded, impedant), artificial neutral.

Chapter 5. Tension adjustment (3 weeks)

Voltage drop in power grids, voltage adjustment method (automatic voltage adjustment at generator terminals, AVR, reactive energy compensation by conventional and modern means, voltage adjustment by autotransformer), introduction to voltage stability.

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical 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 V.G. 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
UE Fundamental Code: UEF 1.1.1
Material: Advanced Power Electronics
VHS: 45h (Lecture: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

To provide the electrical circuit concepts behind the different modes of operation of the inverters to enable the deep understanding of their operation. To provide 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: Modeling methods and simulation of power semiconductors
Idealized Characteristics of Different Types of Semiconductors, Semiconductor Logic Equations, Static Converter Simulation Methods**(2 weeks)**
Chapter 2: Switching mechanisms in static converters Natural switching principle, forced switching principle, calculation of switching losses.
(3 weeks)
Chapter 3: Design Methods for Naturally Switching Static Converters
Switching rules, definition of the switching cell, different types of sources, power exchange rules, direct and indirect converters example: study of a cyclo converter. **(2 weeks)**
Chapter 4: Design Methods for Forced-Switching Solid State Converters
- PWM inverter
- Sinusoidal absorption rectifier
- PWM dimmer
- Switching power supplies **(3 weeks)**

Chapter 5: Multi-Level Inverter **(3 weeks)**
Multi-level concept, topologies, Comparison of multi-level inverters. PWM control techniques for PWM inverters - single-phase and three-phase impedance source.
Chapter 6: Power Quality of Static Converters **(3 weeks)**
- Harmonic pollution due to static converters (Case study: rectifier, dimmer).
- Study of harmonics in voltage inverters.
- Introduction to remediation techniques

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. *Power electronics, from the switch cell to industrial applications. Courses and exercises, A. Cunière, G. Feld, M. Lavabre, Casteilla editions, 544 p. 2012.*
2. *-Technical Encyclopedia "The Techniques of the Engineer", treatise on Electrical Engineering, vol. D4 items D3000 to D3300.*

Semester: 1
UE Fundamental Code: UEF 1.1.1

Material: µ-processors and µ-controllers
VHS: 10:30 pm (Lecture: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives

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

Recommended Prior Knowledge

Combinatorial and sequential logics, industrial automation

Content of the material:

Chapter 1: Architecture and operation of a microprocessor (3 weeks)
Structure of a computer, Circulation of information in a computer, Material description of a microprocessor, Operation of a microprocessor, Memories
Example: The Intel 8086 microprocessor
Chapter 2: Programming in Assembler (2 weeks)
General, The instruction set, Programming method.
Chapter 3: Interrupts and I/O Interfaces (3 weeks)
Definition of an interrupt, Support for an interrupt by the microprocessor, Addresses of interrupt subroutines,
I/O Port Addresses, I/O Port Management
Chapter 4: Architecture and operation of a microcontroller (3 weeks)
Physical description of a µ-controller and how it works. Programming the µ-controller
Example: The µ-controller PIC
Chapter 5: Applications of microprocessors and microcontrollers (4 weeks)
LCD Interface - Keypad Interface - Port Signal Generation Converter Gate - Motor - Control - Control of DC/AC Devices - Frequency Measurement - Data Acquisition System

Evaluation method:

100% review.

Bibliographical references:

1. M. Tischer and B. Jennrich. The PC Bible – System Programming. Micro Application,
   i. Paris, 1997.
2. R. Tourki. The PC Computer – Architecture and Programming – Courses and Exercises.
   i. Centre de Publication Universitaire, Tunis, 2002.
3. H. Schakel. Programming in assembler on PC. Micro Application, Paris, 1995.
4. E. Pissaloux. I80x86 Assembler Practice – Lessons and Exercises. Hermès, Paris, 1994
5. R Zaks and A. Wolfe. From component to system – Introduction to microprocessors.Sybex, Paris, 1988.

Semester: 1
UE Fundamental Code: UEF 1.1.2
Material: Advanced Electrical Machines
VHS: 45h (Lecture: 1h30, TD 1h30)
Credits: 4
Coefficient: 2

Teaching objectives

At the end of this course, the student will be able to establish the general equations of electromechanical energy conversion 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 to take into account the combination of machines with static converters.

Recommended Prior Knowledge

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

Content of the material:

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

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

Chapter 2: **Synchronous machines (4 weeks)**General and equations of the synchronous machine with smooth poles. Study of the operation of the synchronous machine. Differentsystems of excitation. Armature reactions. Elements on the protruding pole synchronous machine without and with shock absorbers. Potier diagrams, diagram of the two reactances and Blondel diagram. Elements on permanent magnet machines. Alternators and Parallel Coupling. Synchronous motors, starting...

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

Chapter 4: **DC Machines (4 weeks)**

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

Evaluation method:

Continuous assessment: 40%; Examination: 60%.

Bibliographical references:

1. *J.-P. Caron, J.P. 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 à l'électrotechnique approfondie, Technique et Documentation, 1981.
4. Paul C. Krause, Oleg Wasyzczuk, Scott S, Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley, Second Edition, 2010.

P S Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 2008.

5. A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, " Electric Machinery", Tata McGraw Hill, 5th Edition, 1992

Semester: 1
UE Fundamental Code: UEF 1.1.2
Subject:Applied numerical methods and optimization
VHS: 45h (Lecture: 1h30, TD 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:
The objective of this course is to present the necessary numerical analysis and optimization tools to achieve this triple goal. The teaching will combine theoretical mathematical concepts and practical implementation on examples of concrete applications.
Recommended prior knowledge:
Mathematics, mastery of the MATLAB environment

Material content:
Chapter 1: Reminders on some numerical methods (3 weeks)
Solving systems of linear and nonlinear equations by iterative methods; Integration and differentiation, etc.
Ordinary Differential Equations (ODE)
- Introduction and canonical formulation of ordinary differential equations and systems of equations;
- Methods of solving: Euler methods; Runge-Kutta methods; Adams' method.

Chapter 2: Partial Differential Equations (PDEs) (6 weeks)
- Introduction and classifications of partial differential problems and boundary conditions;
- Methods of Resolution:
  - Finite difference method (MDF);
  - Finite element method (FEM).

Chapter 3: Optimization Techniques (6 weeks)
Definition and formulation: optimization problems. Classic optimization techniques. Single and multiple optimization with and without constraints.
Optimization Algorithms: Linear Programming, Mathematical Model, Solution Technique, Duality, Nonlinear Programming.

Evaluation method:
Continuous assessment: 40%; Examination: 60%.
Bibliographical references:

1. G.Allaire, Analyse Numérique et Optimisation, Edition de l'école polytechnique, 2012
2. Computational methods in Optimization, Polak , Academic Press,1971.
3. Optimization Theory with applications, Pierre D.A., Wiley Publications, 1969.
4. Taha, H. A., Operations Research: An Introduction, Seventh Edition, Pearson Education Edition, Asia, New Delhi, 2002.
5. S.S. Rao, 'Optimization – Theory and Applications', Wiley-Eastern Limited, 1984

Semester: 1

UE Methodological Code: EMU 1.1
Material: TP: - μ-processors and μ-controllers
VHS: 15h (TP: 1h)
Credits: 1
Coefficient: 1

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

Recommended Prior Knowledge
Combinatorial and sequential logics, industrial automation, algorithmics.

Material content
TP1: Getting started with a programming environment on μ-processor (1 week)
TP2: Programming arithmetic and logical operations in a μ-processor
(1 weeks)
TP3: Using Video Memory in a μ-Processor (1 weeks)
TP4: Managing the μ-processor memory. (2 weeks)
TP5: Controlling a stepper motor by a μ-processor (2 weeks)
TP6: Screen Management (1 weeks)
TP7: Programming the PIC μ-microcontroller (2 weeks)
TP8: Controlling a stepper motor by a PIC μ-microcontroller (2 weeks)

Evaluation method:
Continuous assessment: 100 % .
Bibliographical references:

1. R. Zaks and A. Wolfe. From component to system – Introduction to microprocessors. Sybex, Paris, 1988.
2. M. Tischer and B. Jennrich. The PC Bible – System Programming. Micro Application, Paris, 1997.
3. [3] R. Tourki. The PC Computer – Architecture and Programming – Courses and Exercises. Centre de Publication Universitaire, Tunis, 2002.
4. H. Schakel. Programming in assembler on PC. Micro Application, Paris, 1995.
5. E. Pissaloux. I80x86 Assembler Practice – Lessons and Exercises. Hermès, Paris, 1994

Semester: 1
UE Methodological Code: EMU 1.1
Subject: TP Electrical Power Transmission and Distribution Networks
VHS: 10:30 pm (TP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

To provide the student with 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

Contents of the subject: **Lab N° 1** : Adjustment of the tension by synchronous motor
Lab N° 2: Power distribution and calculation of voltage drops
Lab N° 3: Voltage adjustment by compensating for reactive energy
Lab N° 4: Neutral regime
Lab 5: Interconnected Networks

Evaluation method:

Continuous assessment: 100 % .

Bibliographical references:

1. Sabonnadière, Jean Claude, Lignes et réseaux électriques, Vol. 1, Lignes d'énergie électriques, 2007.
2. Sabonnadière, Jean Claude, Lignes et réseaux électriques, Vol. 2, Méthodes d'analyse des réseaux électriques, 2007.
3. Lasne, Luc, Exercices et problèmes d'électrotechnique: notions de bases, réseaux et machines électriques, 2011.
4. J. Grainger, Power system analysis, McGraw Hill , 2003
5. W.D. Stevenson, Elements of Power System Analysis, McGraw Hill, 1998.

Semester: 1
UE Methodological Code: EMU 1.1
Material: TP Advanced Power Electronics
VHS: 10:30 pm (TP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:
To enable 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: Power factor improvement;
TP3: Elimination of harmonics
TP4: Static Reactive Power Compensators

Evaluation method:
Continuous assessment: 100%;

Bibliographical references:

1. Guy Séguier and Francis Labrique, "The 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, electrical engineering, power electronics. Course summary, problems corrected", , : ELLIPSES MARKETING

Semester: 1
UE Methodological Code: EMU 1.1
Subject: Practical work Applied numerical methods and optimization
VHS: 10:30 pm (TP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:
Familiarize students with the calculus of variations and solve problems using optimization techniques associated with engineering applications.

Recommended prior knowledge:
Ability to apply linear programming theory concepts in electrical engineering problems

Material content:

- Initialization to the MATLAB environment (Introduction, Elementary Aspects, Comments, Vectors and Matrices, M-Files or Scripts, Functions, Loops and Control, Graphics, etc.);**(1 week)**
- Write the following programs to:
  - ❖ Calculate the integral by the following methods: Trapezoid, Simpson and general; (**1 week**)
  - ❖ Solving ordinary differential equations and systems by the different Euler methods, RK-4; (**2 weeks**)
  - ❖ Solving systems of linear and nonlinear equations: Jacobi; Gauss-Seidel; Newton - Raphson; (**1 week**)
  - ❖ Solve PDEs by MDF and FEM for the three (03) types of equations (Elliptical, Parabolic and Elliptical); (**6 weeks**)
  - ❖ Minimize a multivariate function without constraints (**2 weeks**)
  - ❖ Minimize a function with several variables with constraints (inequalities and equalities) by the methods: projected gradient and Lagrange -Newton. (**02 weeks**)

Note: The first 3 sessions can be done as personal work

Assessment method: Continuous assessment: 100%;
Bibliographical references:

1. G.Allaire, Analyse Numérique et Optimisation, Edition de l'école polytechnique, 2012
2. Computational methods in Optimization, Polak , Academic Press,1971.
3. Optimization Theory with applications, Pierre D.A., Wiley Publications, 1969.
4. Taha, H. A., Operations Research: An Introduction, Seventh Edition, Pearson Education Edition, Asia, New Delhi, 2002.
5. S.S. Rao, "Optimization – Theory and Applications", Wiley-Eastern Limited, 1984.

Semester: 1
UE Methodological Code: EMU 1.1
Subject: TP Electrical Machines
VHS: 10:30 pm (TP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives:

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

Recommended prior knowledge:

Good command of computer tools and MATLAB-SIMULINK software.

Material content:

1. Electromechanical characteristics of the asynchronous machine;
2. Circle Diagram;
3. Stand-alone asynchronous generator;
4. Coupling of an alternator to the grid and its operation to the synchronous motor;
5. Determination of the parameters of a synchronous machine;

Evaluation method:

Continuous Assessment: 100%

Bibliographical references:

1. *Th. Wildi, G. Sybille "electrotechnique", 2005.*
2. *J. Lesenne, F. Noielet, G. Seguier, "Introduction à l'électrotechnique approfondie" Univ. Lille. 1981.*
3. *MRetif "Vector Command of Asynchronous and Synchronous Machines" INSA, Pedg course. 2008.*
4. *R. Abdessemed, "Modeling and Simulation of Electric Machines", ellipses, 2011.*

Semester: 1
Teaching unit: UET 1.1.1
Subject: Advanced Python Programming
VHS: 45:00 pm (Lecture: 1h30, TP 1h30)
Credits: 2
Coefficient: 2

Course Objectives:

Targeted Skills:

- Use of computer tools for the acquisition, processing, production, and dissemination of information
- Skills in Python programming and project management
- Skills in data automation and visualization

Objectives:

- Deepen mastery of the Python language and introduce students to the basics of data analysis and artificial intelligence.
- Acquire solid fundamentals in computer science.
- Learn to program in Python and Excel.
- Master task automation.
- Master project management software.

Required Materials:

- A computer with Python installed
- Python libraries: NumPy, Pandas, Scikit-learn, Matplotlib, os.listdir, os.path.exists, os.mkdir, os.rmdir, Matplotlib, Seaborn, Plotly, Requests, BeautifulSoup, Tkinter, PyQT, …
- TensorFlow, PyTorch, …

Prerequisites: Python programming

Course Content:

Chapter 1: Review of Python Programming **(2 weeks)**

1. Introduction: Basic computer concepts and digital tools, Python installation
2. Presentation of the operating system concept: Roles, types (Linux, Windows, …), priority management
3. Introduction to computer networks (Principles, IP Address, DNS, Internet, …)
4. Basic programming: Interactive and script modes, variables, data types, operators, conditional statements, loops (if, for, while)
5. Functions and essential elements: Predefined functions and function creation, standard modules (math, random), strings, lists, basic data manipulation
6. Files, lists, tuples, dictionaries
7. Exercises:
    - Python learning exercises
    - Exercises using the libraries covered in class (Math, Random, NumPy, Pandas, …)

Chapter 2: Programming and Automation **(4 weeks)**

1. Principles of task automation
    - Python libraries for automation:
        - Pandas and NumPy
        - os, shutil: file and folder manipulation
        - openpyxl or pandas: working with Excel or CSV files
    - Definitions and examples of automation (sending emails, …)
2. File manipulation with Python:
    - Using libraries to:
        - Browse a folder (os.listdir)

        - Check if a file or folder exists (os.path.exists)
        - Create or delete folders (os.mkdir, os.rmdir)
        - Visualize data: Matplotlib, Seaborn, Plotly
        - Requests for interacting with APIs
        - BeautifulSoup for data scraping
        - Tkinter, PyQT for graphical data visualization
    - Copy or move files with shutil
    - Search, sort, and generate simple reports
    - Serialization and deserialization (using the pickle module)
    - Object serialization and handling large files (streaming)
3. **Exercises:**
    - Using openpyxl and pandas to read, modify, and write Excel or CSV files to:
        - Create automated reports
        - Automatically extract data
    - Writing scripts to:
        - Process text files (search, sort)
        - Automate technical calculations
        - Manage simple reports (PDF, Excel)
    - Sorting and searching algorithms
    - Implementing a search function in a list
    - File operations
    - Secure navigation (simple network configuration, password management)

Chapter 3: Advanced Excel Training **(2 weeks)**

1. Principles of macros and creating a simple macro
2. Pivot tables
3. Histograms
4. Bar charts
5. Spider charts
6. Etc.
7. Excel exercises

Chapter 4: Learning Gantt Project **(2 weeks)**

1. Introduction to project management:
    - What is a project?
    - Key project management challenges
    - Gantt Project interface
2. Tasks (creation, modification, organization)
3. Time management (project start and end dates)
4. Resource management
5. Exercises on Gantt Project

Chapter 5: Advanced Object-Oriented Programming **(3 weeks)**

1. Code organization:
    - Custom functions, parameters, return values
    - Modules, imports, and packages
2. Complex data structures:
    - Lists, tuples, dictionaries: creation, modification, deletion, iteration
3. Fundamental OOP concepts:
    - Classes, objects, attributes, methods
    - Public, private, and protected attributes
4. Special methods:
    - init, str, repr, len
5. Advanced concepts:

    - Encapsulation, abstraction, inheritance, polymorphism
    - Advanced inheritance, decorators, design patterns, metaclasses
6. Exercises

Chapter 6: Introduction to Data for AI (2 weeks)

1. Introduction to common AI datasets:
    - Iris, MNIST, CIFAR-10, Boston Housing, ImageNet
2. Data preprocessing for Machine Learning:
    - Cleaning, normalization, encoding, data splitting
    - Cross-validation
3. Feature engineering techniques:
    - Selection, feature creation, dimensionality reduction
4. Essential libraries for AI model development:
    - scikit-learn, TensorFlow, Keras, PyTorch

Practical Work (Labs):

Lab 01: Mastering Python basics (control structures, types, loops, simple functions)

1. Initiation
2. Reading and processing text files
3. Managing simple reports (PDF, Excel)

Lab 02:

- Develop a specification for a mini task automation project in Python to identify and automatically send reports by email:

    1. Load data from a file (e.g., experimental measurements)
    2. Perform simple statistics on the data (mean, standard deviation with interpretation)
    3. Generate a chart
    4. Send the results using Python

Lab 03:

1. Excel programming of the dashboard seen in class
2. Creating automated Excel tables
3. Simple macros
4. Conditional formulas
5. VLOOKUP

Lab 04: Organize a meeting in Gantt Project

1. Create a new project:
    - Project name: "Meeting ..."
    - Start date: date and time of the meeting
    - Estimated duration: total meeting duration

2. Define tasks:
    - Agenda points (each becomes a task)
    - Subtasks if needed
    - Initial and final tasks (e.g., "Welcome participants", "Meeting closure")

3. Define resources:
    - Participants (each participant is a resource)
    - Equipment (computer, projector, ...)

4. Estimate durations:
    - Duration of each agenda item

- Transition times between items

5. Create the Gantt chart:
   - Visualize the agenda
   - Identify key points

6. Track progress in real-time

Lab 05: Advanced structures and code organization
(custom functions, dictionaries, modules, modular organization)

Lab 06: Advanced Object-Oriented Programming in Python
(encapsulation, inheritance, special methods, simple design patterns)

Lab 07: File manipulation and data analysis
(reading/writing files, text processing, introduction to Pandas and NumPy)

Lab 08: Data preparation and processing for AI
(loading AI datasets, cleaning, transformation, feature selection)

Final Project:

- Title: Data Analysis and Visualization + Simple Predictive Model
- Skills used: Data reading, OOP, advanced structures, Pandas, Scikit-learn (Oral presentation + written report)
-

Evaluation Method: Exam 60%, Continuous Assessment 40%

Bibliography:

[1].E. Schultz & M. Bussonnier (2020): *Python for the Humanities: Introduction to Data Programming*. Rennes University Press

[2].C. Paroissin (2021): *Practical Data Science with R: Organize, Visualize, Analyze, and Present Data*. Paris: Ellipses

[3].S. Balech & C. Benavent: *NLP Text Mining V4.0*, Paris Dauphine, 12/2019

[4].Allen B. Downey (2015): *Think Python: How to Think Like a Computer Scientist*, O'Reilly Media

[5].Luciano Ramalho (2022): *Fluent Python*, O'Reilly Media

[6].G. Swinnen (2012): *Learn to Program with Python 3*, Eyrolles

[7].E. Matthes (2019): *Python Crash Course: A Hands-On, Project-Based Introduction to Programming*, No Starch Press

[8].Cyrille H. (2018): *Apprendre à programmer avec Python 3*, Eyrolles, 6th edition, ISBN: 978-2212675214

[9].Daniel I. (2024): *Apprendre à coder en Python*, J'ailu

[10].Nicolas B. (2024): *Python, from Beginner to Object-Oriented Programming*, Ellipses, 3rd edition

[11].Ludivine C. (2024): *Selenium: Master Functional Testing with Python*, Eni

Online Resources:

- Official Python Documentation: docs.python.org
- Python Exercises on Codecademy: codecademy.com/learn/learn-python-3
- W3Schools Python Tutorial: w3schools.com/python

III - Detailed programme by subject of the S2 semester

Master's Degree: Electrical Networks

Semester: 2
UE Fundamental Code: UEF 1.2.1
Subject: Modeling and optimization of electrical networks
VHS: 45h (Lecture: 1h30, TD: 1h30)
Credits:4
Coefficient :2

Teaching objectives

At the end of this subject, the student will be able to model an electrical network, to calculate power flow, to calculate fault currents, to deal with the problem of optimal power calculation and prediction of the state of a network.

Recommended Prior Knowledge

- Fundamental electrical engineering, - Electrical energy transmission and distribution networks. Matrix Calculation (Numerical Methods)

Material content

I. Basic modelling of power systems 3 weeks

Reminder on (Representation of sinusoidal signals, Modeling of power system elements (Source, Line, Transformer, Load), System of relative units).

Graph theory applied to power grids, Algorithm for forming admittance and impedance matrices of an RE, - Modification and inversion of the admittance matrix, Techniques of sparse matrices.

II. Calculation of fault currents 3 weeks

Recall (Symmetric Components, Short Circuit Analysis: Thevenin Equivalent Circuit), Symmetric and Asymmetric Short-Circuit Currents of a Large Network, Fault Voltages, Fault Currents in Lines, Generators and Motors, Voltage Phase Shift Readjustment, Short-Circuit Power Calculation, Fault Current Calculation Algorithm.

III. Power flow 3 weeks

Introduction

Equations of load distribution,

Numerical methods applied for charge flow resolution (Gauss-Seidel, Newton Raphson, Fast Decoupled Method, others..., Algorithms and examples)

IV. Optimal distribution of power flow 3 weeks

Introduction, Nonlinear Optimization Function, Cost Characteristics -Production,

Numerical methods applied to an unconstrained and constrained network

Lossless power economic calculation, lossy power economic calculation.

V. Estimating the condition of an electrical network 3 weeks

Measurements of P, Q, I and V,

Methods applied for Estimating the state of an electrical network, Detection and identification of bad measurements, Observability of the network and pseudo-measurements, Consideration of power flow constraints.

Method of evaluation:

Continuous assessment: 40%; Examination: 60%.

References

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

Master's Degree: Electrical Networks

Semester:2
UE Fundamental Code: UEF 1.2.1
Material: Electrical power quality
VHS: 45h (Lecture: 1h30, TD: 1h30)
Credits:4
Coefficient :2

Teaching objectives

The objective of the subject is to study the quality of electrical energy in an electrical network through the degradation of voltage and/or current, disturbances on electrical networks. It is also a question of understanding how nonlinear loads can be incriminated. To study solutions to improve the quality of electrical energy by remedying disturbances by preventing them from occurring when possible or by mitigating them when they are unavoidable.

Recommended Prior Knowledge

Fundamental electrical engineering. Power Electronics.

Material content

I. Introduction to the concepts of energy quality (2 weeks)

II. Deterioration of energy quality (6 weeks)

a. Voltage and current wave deformation: voltage dips, fluctuations, harmonic distortions.
b. Origins of power quality degradation: Nonlinear loads, network faults, special loads.
c. Characterization of wave deformations: Reminder on the frequency decomposition of a non-sinusoidal periodic signal. Electrical quantities in the presence of non-sinusoidal signals (RMS value, instantaneous powers, average powers, power factor and Joule losses... etc).
d. Effects of power quality degradation: Instantaneous and eventual effects on the grid and loads.

III. Standards in force: IEC and IEEE standards for the emission of harmonics at low and medium voltage (2 weeks)

has. Reminder on the frequency decomposition of a non-sinusoidal periodic signal.
b. RMS value, instantaneous powers, average powers, power factor and Joule losses.

IV. Solutions for improving energy quality (5 weeks)

has. Preventive solutions: Reinforcement of the network, modification of load characteristics (Sinusoidal sampling loads).
b. Corrective solutions: Passive filtering (Choice and calculation of passive filters), Active filtering (choice and calculation of active filters).
c. Solutions to minimize imbalances and outages

Evaluation method

Continuous assessment: 40%, Examination: 60%.

References

1. *G. J. WAKILEH, 'Power system harmonics-Fundamental Analysis and Filter Design', Springer-Verlag, 2001.*
2. *Roger C. Dugan, Mark F. Granaghan, 'Electrical Power system Quality', McGraw Hill, 2001*
3. *Energy Quality – Lecture by Delphine RIU – INP Grenoble*
4. *Scheider Technical Specifications Nos. CT199, CT152, CT159, CT160 and CT1*

Semester: 2
UE Fundamental Code: UEF 1.2.1
Material: Centralized and decentralized production
VHS: 10:30 pm (Lecture: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives

This course aims to present the fundamental evolution of energy systems induced by the energy transition, which is a decentralization of these systems.

Recommended Prior Knowledge

Principle of Eclectic Energy Production

Material content

Chapter I: General techniques for the production of electricity (3 weeks)

Electrical energy sources, conventional power plants (thermal and nuclear), Systems service, management and performance.

Chapter II: Distributed Electricity Production (DP) (4 weeks)

Decentralized generation technologies (conventional sources, new and renewable sources (geothermal, small hydro, biomass, micro cogeneration, solar and wind)), advantages.

Chapter III: Connection of the PD to the electricity grid (4 weeks)

Conditions for connecting PD to the electricity system, regulatory and organisational aspects of PD development, technical aspects of connection to HVA networks, interactions between PD and electricity network and current standards.

Chapter IV: Critical infrastructure of the electricity system (4 weeks)

Management in the presence of a high rate of insertion of PDs, the additional technical costs linked to intermittency, methodology for managing critical situations, interest in energy storage, islanding.

Chapter V: Self-generation in renewable energies (μ-grids) (4 weeks)

Concept and operation of microgrids (micro turbines, fuel cells, small diesel generators, photovoltaic panels, mini-wind turbines, small hydro), operation and control of microgrids, hybrid microgrids with distributed generation and accumulation, monitoring and data logging.

Method of evaluation:

Review: 100%.

References:

1. N. Hadjsaïd, "Distribution of electrical energy in the presence of decentralized production", Hermès edition, 2010.
2. R. Caire, "Decentralized Production and Distribution Networks", European University Editions EUE, 2010.
3. B. Multon, "Production d'Énergie Électrique par Sources Renouvelables", Techniques de l'Ingénieur, traité Génie Electrique, D4, 2003.
4. A. Maczulak, 'Renewable Energy: Sources and Methods', Green technology, 2010.
5. N. Hatziargyriou, "Microgrids: Architectures and Control", Wiley-IEEE Press, 2014.

Semester:2
Core UE Code: UEF 1.2.2
Subject: Power system planning
VHS: 45h (Lecture: 1h30, TD 1h30)
Credits:4
Coefficient :2

Teaching objectives

The aim is to enable students to master short-, medium- and long-term power grid planning issues, mainly the extension of generation, transmission and distribution as well as the planning of reactive energy compensation.

Recommended Prior Knowledge

- Electrical energy transmission and distribution networks, - Numerical methods applied and optimization.

Content of the material:

Part 1: Distribution Network Planning

Chapter 1: Costs and Reliability Indices in Power Systems (2 weeks)

Cost of substations, cost of feeder systems, operation and maintenance costs, discounted cost of electrical losses, cost of a line connection, reliability indices (SAIFI, SAIDI, etc.).

Chapter 2: Distribution Network Expansion Planning (3 weeks)

Planning procedure for MV (Medium Voltage) and LV (Low Voltage) distribution networks, planning horizons, technical and operational constraints to be satisfied, selection of the optimal solution, distribution network planning in the presence of distributed generation.

Part 2: Generation–Transmission System Planning

Chapter 1: Long-Term Load Forecasting (2 weeks)

Main determinants of electricity demand, long-term load forecasting methods (trend analysis, econometric models, end-use approach, etc.).

Chapter 2: Generation Expansion Planning (2 weeks)

Generation expansion planning with single access (problem description, cost expressions and constraints to be satisfied, problem formulation), generation expansion planning with multiple access points.

Chapter 3: Substation Expansion Planning (2 weeks)

Problem description, cost expressions and constraints to be satisfied, problem formulation.

Chapter 4: Transmission Network Expansion Planning (2 weeks)

Problem description, cost expressions and constraints to be satisfied, problem formulation.

Chapter 5: Reactive Power Planning (2 weeks)

Problem description, cost expressions and constraints to be satisfied, problem formulation.

Assessment method: Continuous assessment: 40%, Examination 60%

Bibliographical references:

1. D4210 Distribution Networks Structure and Planning by Philippe CARRIVE
2. D 4240 Operation of distribution networks: computer systemsby Marc LECOQ and Robert MICHON
3. D 4070 Electricity transmission and interconnection networks, development and planning. By François MESLIER and Henri PERSOZ.
4. Electricity network planning¨, EDF edition, EYROLS collection
5. Technical Rules for Connection to the Electricity Transmission System and Rules for the Conduct of the Electricity System, by Ministry of Energy and Mines, 2008

Master's Degree: Electrical Networks

Semester:2
Core UE Code: UEF 1.2.2
Material: Control of electro-energy systems
VHS: 45h (Lecture: 1h30, TD: 1h30)
Credits:4
Coefficient :2

Teaching objectives

- Know the different electrical actuation systems (motor + power electronics)
- Know the different types of electric actuator control.
- Be able to establish a simulation model of an electrical system including motor, power electronics and control
- Be able to simulate a model in the Matlab/Simulink environment
- Be able to adjust the PI correctors present in the motor servos by an adapted method

Recommended Prior Knowledge

Electrical machines, machine modelling, power electronics, mechanical concepts, servo control and regulation.

Content of the material:

1. **Reminders** **(1week)**
   (Use of Electrical Systems, Laws of Electric Circuits, Laws of Magnetostatics).
2. **Static converters** **(3 weeks)**
   (General information on modeling, Rectifier, Chopper, Inverter).
3. **The DC motor** **(3 weeks)**
   (Modeling, Power supply with chopper, Current control, Speed control, Position control).
4. **The three-phase synchronous machine** **(2 weeks)**
   (Structure, Modeling, Vector Control).
5. **The three-phase asynchronous motor** **(2 weeks)**
   (Modeling, Directed Rotoric Flow (FRO or FOC), Direct Torque Control (DTC)).
6. **The variable reluctance motor** **(2 weeks)**
   (Principle, Feeding, Area of use).
7. **The piezoelectric motor** **(2 weeks)**
   (Principle, Characteristics)

Evaluation method

Continuous assessment: 40%; Examination: 60%.

References

1. *J.-P. Caron, J.P. 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 à l'électrotechnique approfondie, Technique et Documentation, 1981.
4. Paul C. Krause, Oleg Wasyzczuk, Scott S, Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley, Second Edition, 2010.
5. P S Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 2008.
6. A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, " Electric Machinery", Tata McGraw Hill, 5th Edition, 1992

Master's Degree: Electrical Networks

Semester:2
Methodological UE Code: EMU 1.2
Subject: Techniques for protecting electrical networks
VHS: 37h30 (Lecture: 1h30; TP: 1h)
Credits:3
Coefficient :2

Teaching objectives

The objective of the course is the study of the organization of the protection of electrical networks, disturbances of measurement techniques. The student must know how to do fault detection and how to protect elements of the electrical network and how to coordinate protection.

Recommended Prior Knowledge

Electrical networks, fundamental electrotechnics.

Material content

I. General information on faults in electric power transmission lines
II. Components of a protection system: Instrument transformers, Power relays, Time relays, Intermediate relays, Executing device (circuit breaker)
III. Functions and Principles of Protection:
 - The different protection functions and their codes, - Principle of selectivity
 - Different types of discrimination, - Protection zones
IV. LV and HV protection plans
V. System Protection
 - Protection of a simple radial network (protection with simple discriminations)
 - Protecting a Two-Source Network (Directional Protection)
 - Line protection (differential protection, distance protection)
 - Busbar protection (differential protection), - Transformer protection (differential protection), - Generator protection.
VI. Basic properties of the protection elements: Electromagnetic elements, Semiconductor elements, Analogue principle, Microprocessor elements
VII. Digital Control: Digital Relays, Digital Distance Relays, Digital Differential Relays
VIII. Digital relays: Block diagram of a digital relay, Multiplexing, Analog/digital conversion, Algorithms for evaluating phase quantities, Microprocessor, Control of cut-off devices
IX. Surge protection (spark gaps, guard cables and surge arresters)

Content of the practical work

TP1: Maximum Current Protection, Reverse Time Relay
TP2: Directional Protection, Directional Relay
TP3: Over/Under Voltage Protection, Overvoltage/Under Time Delay Relays
TP4: Optimization of Maximum Current Protection

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

References

6. P.Kundur, "Power System Stability and Control", McGraw-Hill, 1993.
7. Protective Relaying for Power System II Stanley Horowitz ,IEEE press , New York, 2008
8. T.S.M. Rao, Digital Relay / Numerical relays, Tata McGraw Hill, New Delhi, 1989
9. Y.G. Paithankar and S.R Bhide, "Fundamentals of Power System Protection", Prentice-Hall of India, 2003

Master's Degree: Electrical Networks

Semester:2
Methodological UE Code: EMU 1.2
Subject: **TP Modeling and optimization of electrical networks**
VHS: 10:30 pm (TP: 1h30)
Credits:2
Coefficient :1

Teaching objectives

The objective of the material is the realization of programs for the modeling and analysis of steady-state power networks.
The programs to be drawn up, in the case of power flow and the calculation of fault currents, shall make it possible to calculate the voltages at the entrances as well as the currents and powers transiting through the elements of the network. In the case of Economic Dispatching, the program calculates optimal production to minimize costs and finally the condition estimation program will make it possible to estimate the state of an electrical network using optimization techniques.

Recommended Prior Knowledge

Fundamental electrical engineering
Electrical energy transmission and distribution networks

Material content

Lab 1: Modeling of transmission line parameters.
TP2: Construction of busbar admittance and impedance matrices
Lab 3: Modeling of power flow by the Gauss-seidel algorithm
TP4: Modeling of power flow by the Newton-Raphson algorithm
Lab 5: Calculating faults on an electrical network
TP 6: Economic Dispatching

Evaluation method

Continuous assessment: 100 %.

References

6. GöranAndersson, "Modelling and Analysis of Electric Power Systems", ETH Zürich, 2008
7. R. Natarajan, Computer-Aided Power System Analysis, Marcel Dekker, 2002.
8. A. R. Bergen and V. Vittal: Power System Analysis, Prentice-Hall, 2000.
9. H. Saadat: Power System Analysis, McGraw-Hill, 1999.
10. WILLIAM D. STEVENSEN, "Elements of power system analysis", Edition (Dunod, Paris, 1999).
11. B. M. Weedy and B. J. Cory: Electric Power Systems, John Wiley & Sons, 1998.
12. J. Arrillaga, C. P. Arnold, "COMPUTER ANALYSIS OF POWER SYSTEMS", University of Canterbury, Christchurch, New Zealand, JOHN WILEY & SONS, 1990.

Master's Degree: Electrical Networks

Semester:2
Methodological UE Code: EMU 1.2
Subject: TP Quality of electrical energy
VHS: 10:30 pm (TP: 1h30)
Credits:2
Coefficient :1

Teaching objectives

The objectives of the subject are:
1. Measurement of harmonic distortions of voltage and current in the presence of pollutant loads.
2. Simulate the different means of harmonic mitigation.

Recommended Prior Knowledge

Matlab/Simulink software, Fundamental electrical engineering, Frequency analysis, resonant circuits.

Material content

TP 1: Simulation of common nonlinear loads (current and voltage measurement, harmonic spectra, power).
TP 2: Propagation of harmonics in an electrical network.
TP 3: Improvement of the power quality by sinusoidal sampling structures.
TP 4: Improved power quality by passive filtering.
TP 5: Improvement of the power quality by Active Filtering (Demonstration TP).

Evaluation method

Continuous assessment: 100 % .

References

1. *G. J. WAKILEH, 'Power system harmonics-Fundamental Analysis and Filter Design', Springer-Verlag, 2001.*
2. *Roger C. Dugan, Mark F. Granaghan, 'Electrical Power system Quality', McGraw Hill, 2001*
3. *Energy Quality – Lecture by Delphine RIU – INP Grenoble*
4. *Scheider Technical Specifications Nos. CT199, CT152, CT159, CT160 and CT1*

Master's Degree: Electrical Networks

Semester:2
Methodological UE Code: EMU 1.2
Material: **TP Control of electro-energy systems**
VHS: 10:30 pm (TP: 1h30)
Credits:2
Coefficient :1

Teaching objectives

The objectives of the subject are to understand and be able to:
Construct the block diagram of DC and AC machines powered by static converters using Simulink software under Matlab.
- Control the speed of a direct current machine by static converters and by a four-quadrant chopper,
- Perform the vector control with oriented rotor flow of the MAS as well as the autopiloting of the synchronous machine

Recommended Prior Knowledge

Electrical machines, machine modelling, power electronics, mechanical concepts, servo control and regulation.

Material content

TP1: Variation of the speed of a DC machine by converter by rectifier and series chopper.
TP2: Variation of speed of a DC machine by a four-quadrant chopper
TP3: V/f control of the asynchronous machine,
TP4: Scalar control of the current of the MAS,
TP5: Oriented Rotational Flow Vector Control of the MAS
TP6: Autopiloting the synchronous machine

Evaluation method

Continuous assessment: 100%;

References

1. *Industrial Electrical Engineering, Guy Séguier and Francis Notelet, Tech and Doc, 1994*
2. *L'Electronique de pouvoir, Guy Séguier, Dunod, 1990*
3. *Modeling and control of the asynchronous machine, J.P. Caron and J.P. Hautier, Technip, 1995*
4. *Control of Electrical Drives, W. Leonard, Springer-Verlag, 1996*
5. *Vector control of AC machines, Peter Vas, Oxford university press, 1990*
6. *Control of variable-speed machines, Techniques de l'ingénieur, vol D3. III, n°3611, 1996*
7. *Electric actuators, Guy Grellet and Guy Clerc, Eyrolles, 1997*

Master's Degree: Electrical Networks

Semester: 2
Teaching unit: UED 1.2.1
Subject: Fundamentals of Applied Artificial Intelligence
VHS: 45h (Lecture: 1h30, TD: 1h30)
Credits: 2
Coefficient: 2

Targeted Skills:

- Identify opportunities for Artificial Intelligence in engineering sciences.
- Understand the ethical implications of AI and best practices for its responsible use.
- Ability to apply AI techniques to problem-solving.

Objectives:

- Mastery of AI algorithms.
- Introduction to the fundamental concepts, tools, and applications of modern Artificial Intelligence, with emphasis on practical implementation using Python and its libraries.
- Advanced proficiency in Python programming.
- Understanding AI approaches for problem-solving.

Prerequisites:

- Advanced Python programming.

Required Materials:

- A computer with Python installed.
- Python libraries: NumPy, Pandas, Scikit-learn, Matplotlib, os.listdir, os.path.exists, os.mkdir, os.rmdir, Seaborn, Plotly, Requests, BeautifulSoup, Tkinter, PyQt, etc.
- TensorFlow, PyTorch, etc.

Course Content:

Chapter 1: Introduction to Artificial Intelligence **(1 week)**

1. Definitions and application fields of Artificial Intelligence (AI).
2. Historical evolution of AI.
3. Introduction to major domains:
   - Machine Learning
   - Deep Learning

Chapter 2: Fundamental Mathematics for AI **(1 week)**

1. Linear Algebra: vectors, matrices, products, norms.
2. Probability and Statistics:
   - Random variables, expectation, variance.
   - Common probability distributions: normal, binomial, uniform.
3. Simple Linear Regression:
   - Formulation, cost function, optimization.
   - Implementation using Scikit-learn.
4. Exercises:
   - Matrix manipulation using the NumPy library (Python).
   - Linear regression exercise (using a Python library such as Scikit-learn).
   - Introduction to and explanation of the Matplotlib library (Python).

Chapter 3: Machine Learning **(3 weeks)**

1. Key concepts: data, models, features, labels, generalization.
2. Phases of a learning pipeline: training, validation, testing.

3. Types of learning:
    - Supervised learning
    - Unsupervised learning
    - Reinforcement learning (overview)
4. Exercises:
    - In-depth study and reinforcement of the concepts covered in class.

Chapter 4: Supervised Classification (3 weeks)

1. Principle of training a simple classification model.
2. Models and algorithms:
    - Support Vector Machines (SVM)
    - Decision Trees
3. Performance evaluation:
    - Confusion matrix, precision, recall, F1-score.
4. Exercises:
    - How to use Scikit-learn.
    - Comparison of several models on a given dataset.

Chapter 5: Unsupervised Learning

1. Concept of clustering.
2. Algorithms:
    - K-means
    - DBSCAN (Density-Based Spatial Clustering of Applications with Noise)
3. 2D visualization and interpretation of results.
4. Exercises:
    - How to apply a clustering algorithm to a dataset.
    - How to visualize clusters.

Chapter 6: Neural Networks

1. Architecture of a neural network:
    - Perceptron
    - Layers and hidden layers, weights, biases
    - Activation functions: ReLU, Sigmoid, Softmax, etc.
    - Application exercises
2. Introduction to Deep Learning:
    - Concept of deep layers
    - Introduction to Convolutional Neural Networks (CNNs)
3. Exercises:
    - Introduction to TensorFlow and PyTorch
    - Analysis of a dataset and text data for sentiment prediction
    - Additional practical applications.

Chapter 7: Introduction to Neural Networks

Chapter 8: Mini Project (Supervised Individual Work Outside Class Hours)

Development of a complete classification or clustering model, including preprocessing, training, and visualization. Students must select and complete a project from start to finish (topics assigned at the beginning of the semester), such as:

- Handwritten character recognition.
- Natural disaster prediction.
- Development of a chatbot capable of answering frequently asked questions within a company in a natural manner.
- Development of a system capable of distinguishing normal machine sounds from those indicating anomalies (faulty bearing, excessive vibration, etc.).
- Development of a system (mini-AI) capable of analyzing sentiments expressed in social media posts regarding a product, brand, or event.

Practical Work (Laboratory Sessions)

Lab 01: Initialization

Lab 02:

- Implement a simple linear regression using Scikit-learn (for example).
- Visualize results using Matplotlib.

Lab 03:

- Machine learning pipeline and data splitting.
- Further exploration of concepts covered in lectures.

Lab 04:

- Use Scikit-learn to train a simple classification model.

Lab 05:

- Implement a clustering algorithm on a dataset.
- Visualize clusters: Unsupervised clustering (K-means, DBSCAN).

Lab 06:

- Build a simple neural network using TensorFlow, PyTorch, or Keras.
- Build a simple Convolutional Neural Network (CNN) for image classification (e.g., MNIST dataset).

Evaluation method

Continuous assessment: 40%, Examination: 60%.

References

[1]. Ganascia, J.Gabriel (2024) : l'IA expliquée aux humains. Paris France- Edition le Seuil.
[2]. Anglais, Lise, Dilhac, Antione, Dratwa, Jim et al. (2023) : L'éthique au coeur de l'IA. Quebec Obvia.
[3]. J.Robert (2024) : Natural LanguageProcessing (NLP) : définition et principes – Datasciences. Lien : https://datascientest.com/introduction-au-nlp-natural-language-processing
[4]. Qu'est-ce que le traitement du langage naturel. Lien : https://aws.amazon.com/fr/what-is/nlp/
[5]. M.Journe : Eléments de Mathématiques discrètes – Ellipses
[6]. F.Challet : L'apprentisage profond avec Python – Eyrolles
[7]. H.Bersini (2024) : L'intelligence artificielle en pratique avec Python – Eyrolles
[8]. B.Prieur (2024) : Traitement automatique du langage naturel avec Python – Eyrolles
[9]. V.Mathivet(2024) : Implémentation en Python avec Scikit-learn – Eyrolles
[10]. G.Dubertret (2023) : Initiation à la cryptographie avec Python – Eyrolles
[11]. S.Chazallet (2023) : Python 3 – Les fondamentaux du langage – Eyrolles
[12]. H.Belhadef, I.Djemal : Méthode TALN – Cours de l'unievrsité de Msila - Algérie .

Master's Degree: Electrical Networks

Semester: 2
Teaching unit: UET 1.2
Subject: Ethics, Professional Conduct and Intellectual Property
VHS: 22:30 p.m. (Lecture: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:

Develop student awareness of ethical principles. To introduce them to the rules that govern life at the university (their rights and obligations vis-à-vis the university community) and in the world of work. Raise awareness of respect for and appreciation of intellectual property. Explain to them the risks of moral ills such as corruption and how to combat them.

Recommended prior knowledge:

Foundations of Ethics and Professional Deontology.

Content of the material:

A- Ethics and deontology

1. Overview of the MESRS Charter of Ethics and Professional Conduct: Integrity and honesty, Academic freedom, Mutual respect, Commitment to scientific truth, objectivity, and critical thinking, Equity and fairness, Rights and obligations of students, faculty members, and administrative and technical staff.

2. Responsible and Ethical Research

- Respect for ethical principles in teaching and research.
- Responsibilities in teamwork: Equal professional treatment, Conduct against discrimination, Pursuit of the general interest, Inappropriate conduct in collaborative work.
- Adopting responsible conduct and combating misconduct: Responsible behavior in research, Scientific fraud, Measures against fraud, Plagiarism (definition, different forms, procedures to avoid unintentional plagiarism, plagiarism detection, sanctions against plagiarism, etc.), Data falsification and fabrication.

3. Ethics and Professional Conduct in the Workplace

Legal confidentiality within the company, Loyalty to the company, Responsibility within the organization, Conflicts of interest, Integrity (corruption in the workplace, its forms, consequences, prevention measures, and sanctions against corruption).

B- Intellectual property

I- Fundamentals of intellectual property **(1 weeks)**

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

II- Copyright **(5 weeks)**

1. **Copyright in the digital environment**
   Introduction. Copyright of databases, copyright of software. Specific case of free software.
2. **Copyright in the Internet and Electronic Commerce**
   Domain name law. Intellectual property on the internet. E-commerce Site Law. Intellectual Property and Social Media.
3. **Patent**
   Definition. Rights in a patent. Usefulness of a patent. Patentability. Patent application in Algeria and around the world.
4. **Trade marks and designs**
   Definition. Trademark Law. Design law. Designation of Origin. The secret. Counterfeiting .
5. **Geographical Indications Law**
   Definitions. Protection of Geographical Indications in Algeria. International treaties on geographical indications.

III- Protection and enhancement of intellectual property **(3 weeks)**

How to protect intellectual property. Violation of rights and legal tool. Valuation of intellectual property. Protection of intellectual property in Algeria.

C – Ethics, Sustainable Development, and New Technologies

Relationship between ethics and sustainable development, Energy efficiency and responsible resource management, Bioethics and new technologies (Artificial Intelligence, scientific progress, humanoids, robots, drones).

Method of evaluation:

Review: 100%

Bibliographical 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 28 July 2016 laying down 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, De la déontologie enseignante. Paris, PUF, 2009.
5. Racine L., Legault G. A., Bégin, L., Éthique et ingénierie, Montréal, McGraw Hill, 1991.
6. Siroux, D., Déontologie: Dictionnaire d'éthique et de philosophie morale, Paris, Quadrige, 2004, p. 474-477.
7. Medina Y., La déontologie, ce qui va changer dans l'entreprise, éditions d'Organisation, 2003.
8. Didier Ch., Penser l'éthique des ingénieurs, Presses Universitaires de France, 2008.
9. Gavarini L. and Ottavi D., Editorial. Professional Ethics in Training and Research, Research and Training, 52 | 2006, 5-11.
10. Caré C., Morale, éthique, déontologie. Administration and Education, 2nd Quarter 2002, No. 94.
11. Jacquet-Francillon, François. Concept: professional ethics. Letélémaque, May 2000, No. 17
12. Carr, D. Professionalism and Ethics in Teaching. New York, NY Routledge. 2000.
13. Galloux, J.C., Industrial Property Law. Dalloz 2003.
14. Wagret F. and J-M., 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. University of Technology Belfort-Montbéliard
17. Fanny Rinck and Léda Mansour, Literacy in the Digital Age: Copying and Pasting Among Students, Université Grenoble 3 and Université Paris-Ouest Nanterre la Défense Nanterre, France
18. Didier DUGUEST IEMN, Citing 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. Emanuela Chiriac, Monique Filiatrault and André Régimbald, A Student's Guide: Intellectual Integrity, Plagiarism, Cheating and Fraud... avoid them and, above all, how to 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 World Intellectual Property Organization website www.wipo.int
24. http://www.app.asso.fr/

III - Detailed programme by subject of the S3 semester

Semester 3 Master's Degree: Electrical Networks

Semester: 3
UE Fundamental Code: UEF2.1.1
Subject: Electrical network management
VHS:45h00 (Lecture: 1h30, TD 1H30)
Credits: 4
Coefficient: 2

Teaching objectives

The objective of the course is to deal with the functions and computer architecture of the control centres of the electricity transmission and distribution networks: role of the control centres; real-time aspects; architecture; data acquisition and remote control; estimation and prediction of the state of the network; centralized settings; optimization; reliability and security; exchange of information between applications and between control centres.

Recommended prior knowledge:

- Electrical transmission and distribution networks

Material content

Chapter I. General information on the "production-transmission-distribution" system 1 week

Electricity system, Constitution of the electricity system, Direct current Alternating current, Transmission of electrical energy, Structure of the transmission network, High voltage substations, Long-distance power lines, Perspective of direct current transmission, The Algerian electricity system.

Chapter II. Interconnection of transmission networks and voltage quality 2 weeks

Case of two interconnected networks, Case of several interconnected networks, Reasons for interconnections, Advantages of interconnection, Planning of transport and interconnection networks.

Chapter III. OPR Conduct 2 weeks

Driving centres, Production-consumption balance, Consumption forecasting and production planning, Frequency adjustment, Management of the voltage plan on the transmission network, Control of energy transits in an interconnection network.

Chapter IV. Network Tuning 3 weeks

Frequency control (Primary, secondary and tertiary frequency control), Voltage control (Primary, secondary and tertiary voltage control), New installations – reference construction capacities.

Chapter V. Data acquisition and remote control 3 weeks

Data acquisition, Remote monitoring of the power system, Control of the power system or remote control, The SCADA system, The different configurations of SCADA systems, Decision support tools, Computer control systems,

Chapter VI. Electrical System Safety and Defence Plans 2 weeks

Operational safety of the electrical system, Main degradation phenomena, System safety in normal and exceptional conditions, Management of separate networks - Restoration of the network, Operation in exceptional conditions and support of the network, Maintenance of the effectiveness of the means of safeguard and defence.

Assessment method: Continuous assessment: 40%exam 60%

References:

1. VIRLOGEUX, "Systèmes de téléconduite des postes électriques", Techniques de l'Ingénieur, D4850, 1999.
2. Pierre BORNARD, "Conduite d'un système de production-transport", Techniques de l'Ingénieur, D4080, 2000.
3. Gwilherm POULLENNEC, "A la découverte du système électrique", Ecole des Mines de Nantes, 2007.
4. RTE, "Users' contribution to the performance of the PTN", Réseau de Transport d'Electricité, 2014

Semester 3 Master's Degree: Electrical Networks

Semester: 3
UE Fundamental Code: UEF2.1.1
Subject: Stability and dynamics of power grids
VHS: 45h (Course: 1h30, TD: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives

- Understand the physics of transient phenomena in order to limit their importance and effects
- Master the transient analysis of a power electrical system and understand the stability issue.
- Understand the technical and economic aspects of adjusting the frequency and amplitude of the voltage.
- To enable the student to develop different safety strategies using power flow calculation, transient and long-term stability software.

Recommended prior knowledge:

- Electrical transmission and distribution networks
- Simulation of power grids

Material content

I. 1. Notions and definitions;
   1.1. Electromechanical transient regimes,
   1.2. Electromagnetic transient regimes,
   1.3. Elements of the machine-system link,
   1.4. Notions of stability: static, dynamic, etc.

II. Propagation of transient phenomena on power lines
   II.1 Study of wave propagation in the frequency domain
   II.2 Propagation of Surge Waves in the Presence of Injection or Internal System Disturbance

III. Calculation of the transient regimes of lines by the moving wave method

IV. Dynamic stability, transient stability, voltage stability, long-term stability.

V. Complete study of a machine connected to an infinite network with AVR and PSS - Resolution by the equal-area criterion method
- Numerical ResolutionVI. Multi-machine case study

VII. Methods of Stability Improvement: PSS, SVC, TCSC and TCPST

Assessment method: Continuous assessment: 40%exam 60%

References:

[1] M.Grappe "Stability and Safeguarding of Electricity Networks", Edition HERMES, 2003
[2] YoshihideHase, Power Systems engineering, British Library Cataloguing in Publication Data, USA
[3] ARIEH L. SHENKMAN, Transient analysis of electric power circuit hand book, Holon Academic Institute of Technology, Springer revue, Netherlands, 2005.
[4] Electric Power Generation, Transmission, and Distribution, Leonard L. Grigsby, University of California, Davis, 2006.

Semester 3 Master's Degree: Electrical Networks

Semester: 3
UE Fundamental Code: UEF2.1.1
Subject: Smart Grids
VHS: 22:30 (Lesson: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives

This course aims to present the development of the smart electricity grid of tomorrow, which is communicative, interactive and multidirectional through the use of new information and communication technologies.

Recommended prior knowledge:

Basics of how the power grid works

Material content

Chapter I: Introduction to Smart Grids

I-1 Definition, Causes of their emergence, Expected benefits, Impacts and brakes, I-2 Intelligent systems technology, I-3 Structural transformation of the electricity system following its ICT endowment, I-4 Reorganization of the company,

Chapter II: Socio-economic challenges of smart electricity grids,

II-1 Opening of electricity markets, Tariffs, II-2 Regulation, legislation and regulation (standards, directives, compliance)); II-3 Industrial Standards and Practices,

Chapter III: Adaptation of energy systems

III-1 Diversity of renewable resources and particularities; III-2 Exploitation of variable renewable energies, III-2 Valorisation of variable energies, III-4 Storage strategies

Chapter IV: Management and management of electricity networks

IV-1 The contribution of intelligent systems: control of energy demand, management of consumption peaks "the Consumer-actor", management and flexibility of demand, crisis management (blackout); IV-2 Smart metring, IV-3 Powerline

Chapter V: Service developments related to intelligent systems

V-1 Growth of the ICT Industry, V-2 Research and Development; V-3 Computer Security; V-4 Techno-economic calculation and decision criteria (Manager-consumer).

Assessment method: 100% exam

References:

1. N. Simoni, "From Smart Grids to the New Generation of Services", Hermès, 2007
2. **R.C. Dugan, M.F.McGranaghan, S. Santoso, H. W. Beaty,** 'Electrical Power Systems Quality', McGraw Hill Companies, 2004.
3. S. Znay, M.P. Gervais, "Les réseaux intelligents", Hermès edition, 1997

Semester 3 Master's Degree: Electrical Networks

Semester: 3
UE Fundamental Code: UEF2.1.2
Subject: Integration of renewable resources into electricity grids
VHS:45h00 (Lecture: 1h30, TD 1H30)
Credits: 4
Coefficient: 2

Teaching objectives

Renewable resources have very interesting potential contributions in terms of energy and economy. However, depending on their penetration rate, these new energy sources could have significant consequences for the operation and security of power grids. For a massive insertion of renewable resources into the system, these impacts will not only be found at the level of the distribution network, where most renewable resources are connected, but they will affect the entire system. It is therefore necessary to look at how to evolve the defence and reconstitution plans of the system in the new context, and how to make effective use of the potential of renewable resources to support the system in critical situations.

Recommended prior knowledge:

Structure of electricity grids, Renewable energies

Material content

Chapter I: Renewable energies in electricity grids

- Description, operation and quality of electrical energy; - Analysis of power systems (frequency balancing control, - Voltage control, power flow calculation, reactive power management, etc.), - Connection to the electricity grid of distributed generation;

Chapter II: Impacts of the integration of renewable resources on the distribution network

Power transit direction; - Voltage profile (Slow voltage variations, Voltage jolts, Flicker, Harmonics, Disturbances of signals transmitted on the network, etc.);
- System stability; - Protection plan (Resistance in normal and exceptional conditions, resistance to voltage dips, interaction with the protection plan); - System Observability and Controllability; - Continuity and quality of service.

Chapter III: Impacts of the integration of renewable resources on the transmission system

Uncertainty about the planning phase; - Need to strengthen the network;
- Uncertainty about the operating reserve margin; - Sensitivity related to reagent management;
- Sensitivity linked to the untimely triggering of decentralised production;

Chapter IV: Procedures for the restoration of the electricity system

- Islanding; Use of fast electronic power controllers (FACTS); - Design of control algorithms; - Modern telecommunications and information systems; •Automatic defect detection; etc.

Assessment method: Continuous assessment: 40%, Examination: 60%

References:

1. B. Multon, "Production d'Énergie Électrique par Sources Renouvelables", Techniques de l'Ingénieur, traité Génie Electrique, D 4, 2003.
2. L. Freris, D. Infield, 'Renewable Energies for Electricity Production', Dunod, 2013
3. D. Das, 'Electrical Power Systems', New Age International Publishers, 2006.
4. M. Crappe, S. Dupuis, ' Stability and Safeguarding of Electrical Networks', Hermès, 2003.
5. A. Maczulak, 'Renewable Energy: Sources and Methods', Green technology, 2010.

Semester 3 Master's Degree: Electrical Networks

Semester: 3
UE Fundamental Code: UEF2.1.2
Subject: Industrial power grids
VHS:45h00 (Lecture: 1h30, TD 1H30)
Credits: 4
Coefficient: 2

Teaching objectives

The objective of the subject is to give students the necessary knowledge of industrial electrical networks (architectures, diagrams and plans), the calculation of the power balance, energy minimization, choice of electrical ducts, fault calculation and protection.

Recommended prior knowledge:

General information on electrical networks

Material content

I. Network architectures 2 weeks

General structure of a private distribution network, The power source, HVB delivery stations, HVA delivery stations, HVA networks and HVB networks within the site, Industrial networks with internal production.

II. Neutral regimes (RN) 3 weeks

The different regimes of neutral; The influence of the RN and diagrams of the earthing connections used in LV; Indirect contact in low voltage following the RN; Protection, Particularities of WILD and cut-off of neutral conductor and phase conductors; Influence of cut-off rules on the switchgear and protection of conductors; Interaction between HV and LV; Comparison of different low-voltage-choice RNs; RN used in high voltage.

III. Receivers and their power constraints 1 week

Disruptions in industrial networks; Remedies to protect against flicker;
Electric motors, 4. Other receptors,

IV. Power Sources 1 week

Feeding by RDPs; Alternators (synchronous generators), asynchronous generators, Advantages and disadvantages; Uninterruptible power supplies (UPS),

V. Power Balance1 week

V. Surges and Isolation Coordination 1 week

Power surges; Surge protection devices; Coordination of insulation in an industrial electrical installation,

VI. Determination of conductor cross-sections 3 weeks

Determination of conductor cross-sections and choice of LV protection devices;
Determination of MV conductor cross-sections; Calculation of the economic section

VII. Reactive Energy Compensation 2 weeks

Interest on RE compensation, Improvement of the cos φ; RE compensation equipment; Location of capacitors; Determination of the compensation power in relation to the energy bill; Compensation at the terminals of a transformer; Asynchronous motor compensation; Optimal compensation; Capacitor bank engagement and protection; Presence of harmonics

Assessment method: Continuous assessment: 40%exam 60%

References:

(Books and handouts, websites, etc.).

[1] Denis MARQUET, Didier Mignardot, Jacques SCHONEK, "Guide de l'installation électrique 2010 - IEC and French national international standards NF", Schneider Electric, 2010
[2] Jean Repérant, "Industrial Electrical Networks - Introduction", Tech. del'Ing., D5020, 2001
[3] Jean Repérant, "Industrial Electrical Networks - Engineering", Tech. del'Ing., D5022, 2001
[4] Dominique SERRE, "Installations électriques LV - Protections électriques", Tech. del'Ing., D5045, 2006
[5] SOLIGNAC (G.). – Guide de l'Ingénierie électrique des réseaux interne d'usines, 1076 p.bibl. (30 ref.) lectra Tech & Doc Lavoisier, EDF. Paris, 1985.

Semester 3 Master's Degree: Electrical Networks

Semester: 3
Core UE Code: EMU 2.1
Material: High Voltage Techniques
VHS: 60h (Lecture: 1h30, TD 1h30, TP 1h00)
Credits: 5
Coefficient: 3

Teaching objectives

The objective of the material is to control electrical energies both in terms of understanding physical phenomena and in terms of the design and sizing of the insulation of high voltage equipment. Also, at the end of this course, the student will be able to master the problems of insulation coordination in electrical networks.

Recommended prior knowledge:

Notions of fundamental physics, fundamental electrical engineering

Content of the material:

I. INTRODUCTION

HT Goals and Methodology

II. COORDINATION OF SEGREGATION

II.1.Insulation and insulation,
II.2. Gradation of isolation,
II.3. Dimming of isolation levels in a network

III. CONTROL OF ELECTRIC FIELDS

III.1. Electric field and dependence of form,
III.2. Control of the electric field,
III.3. Methods for evaluating the electric field
III.4 Crown discharge - Impact on the electricity grid

IV. SURGES

IV.1 Definitions,
IV.2Origin of overvoltages,
IV.3Propagation of waves in lines with distributed constants,
IV.4Atmospheric surges,
IV.5. Insulators for high-voltage overhead lines,
IV.6 Protective Devices

V. HIGH VOLTAGE GENERATORS

Alternating voltage generators - transformer, cascade transformer, resonant circuit - continuous voltage - HV rectification, Schenkel doubler, etc., shock generator - Marx generator, etc.

VI. LABORATORY HIGH-VOLTAGE MEASUREMENT

VI.1.Devices for measuring peak values,
VI.2. Shock voltage measuring devices,
VI.3.The Sphere Spark Gap

Practical work of the subject

1. Crown Discharge: "Voltage-current" characteristic in positive and negative polarity. Visualization of Trichel pulses (variable electrode radius).
2. Dielectric barrier discharge
3. Attraction and protection zone of a vertical and horizontal lightning rod
4. Breakdown of liquid and solid insulation

5. Measurement techniques of different types of voltage: alternating voltage, direct voltage, impulse, electric field measurement

Assessment method: Continuous assessment: 50%; Examination: 50%.

References:

[1]E.Kuffel, W.S Zanegl, J.Kuffel "High Voltage engineering: Fundamentals", 2nd edition, Edition Newnes, 2006

[2] C.Gary "Dielectric properties in air and very high voltage", Editions Eyrolles, 1984

[3] M.Aguet, M.Ianovic "Traité d'électricité, Volume XIII: Haute Tension", Edition GEORGI, 1982

[4] P. Bergounioux, "High Voltage", Edition Willamblake & Co, 1997

[5] J. Arrillaga, "High Voltage Direct Current Transmission", Peter Pregrinus, London, 1983

Semester 3 Master's Degree: Electrical Networks

Semester: 3
Core UE Code: EMU2.1
Subject: Stability and Dynamics of Electrical Networks
VHS: 22:30 p.m. (TP: 1h30)
Credits: 2
Coefficient: 1

Teaching objectives

The objective of the practical work is to provide sufficient knowledge to enable the future electrical engineer to design and size the insulation of high-voltage equipment and to master the problems of insulation coordination in electrical networks with which he or she would be confronted

Recommended prior knowledge:

Fundamental Physics and Power Grids

Material content

TP1: Transient Analysis of 1st Order and 2nd Order Linear Circuits
TP2: Study of the transient regime of a power line
a) Powering up the line not compensated at no load
b) Powering up the line not compensated under load
TP3: Series/parallel compensation of a three-phase line
TP4: Dynamic stability simulation of an infinite bus machine system

Assessment method: Continuous assessment: 100%

References

[1]- E.Kuffel, W.S Zanegl, J.Kuffel "High Voltage engineering: Fundamentals", 2nd edition, Newnes Edition, 2006
[2]- C.Gary "Dielectric properties in air and very high voltage", Editions Eyrolles, 1984
[3]- M.Aguet, M.Ianovic "Traité d'électricité, Volume XIII: Haute Tension", Edition GEORGI, 1982
[4]- P.Bergounioux "High Voltage", Edition Willamblake & Co, 1997
[5] J. Arrillaga, "High Voltage Direct Current Transmission", Peter Pregrinus, London, 1983

Semester 3 Master's Degree: Electrical Networks

Semester: 3
Core UE Code: EMU2.1
Subject: TP Industrial electrical networks
VHS: 22:30 p.m. (TP: 1H30)
Credits: 2
Coefficient: 1

Teaching objectives

Recommended prior knowledge:

General information on the stability of electricity networks

Material content

TP1: Calculation and choice of electrical pipes and protection by calculation software
TP2 : Grounding Diagrams
TP3: Technical and economic optimization of an internal industrial network
Educational visits (Visit to industrial sites)
Mini project

Assessment method: Continuous assessment: 100%

References

[1] Denis MARQUET, Didier Mignardot, Jacques SCHONEK, "Guide de l'installation électrique 2010 - IEC and French national international standards NF", Schneider Electric, 2010
[2] Jean Repérant, "Industrial Electrical Networks - Introduction", Tech. del'Ing., D5020, 2001
[3] Jean Repérant, "Industrial Electrical Networks - Engineering", Tech. del'Ing., D5022, 2001
[4] Dominique SERRE, "Installations électriques LV - Protections électriques", Tech. del'Ing., D5045, 2006
[5] SOLIGNAC (G.). – Guide de l'Ingénierie électrique des réseaux interne d'usines, 1076 p.bibl. (30 ref.) Lectra. Tech.& Doc. Lavoisier, EDF. Paris, 1985.

Semester: 3
Teaching unit: UED2.1
Material: Reverse Engineering
VHS: 45h00 pm (lecture: 1h30, Practical Workshop: 1h30)
Credits: 2
Coefficient: 2

Course Objectives

- Understand the principles and goals of Reverse Engineering (RE) in Science and Technology (ST).
- Get familiar with RE tools and methods specific to the field.
- Appreciate the value and ethical considerations of RE in product design, manufacturing, and quality assurance.
- Encourage critical thinking, technical curiosity, reasoned reverse engineering, and innovation.
- Learn to analyze, document, and model an existing system without initial documentation.

Targeted Competencies

- Decompose and analyze an existing system.
- Accurately reproduce a technical diagram or 3D model from an existing product.
- Apply diagnostic and simulation tools.
- Work collaboratively on an exploratory project.
- Identify legal limits of reverse engineering.

Prerequisites : Fundamental knowledge in the relevant specialty.

Course Content

1. Introduction to Reverse Engineering

- History, legal and ethical considerations.
- Definitions and application areas: hardware, software, processes.
- Domains: maintenance, remanufacturing, cybersecurity, competitive intelligence.

2. General Methodology

- Black-box system analysis.
- Functional decomposition.
- Block diagrams, inputs/outputs, energy or information flows.

3. Hardware Reverse Engineering

- Electrical devices and electronic boards: visual inspection, component identification.
- Tools: multimeter, oscilloscope, logic analyzer.
- Recognition and reconstruction of electrical schematics.
- Schematic design using KiCad / Fritzing / Proteus / EPLAN Electric P8 / QElectroTech.

4. Software Reverse Engineering

- Static analysis of binaries (.exe, .hex).
- Decompilation and disassembly (intro to Ghidra, IDA Free, Hopper).
- Behavior observation: sniffing, monitoring (e.g., Wireshark).
- Microcontroller-specific: flash memory reading, firmware extraction.

5. Mechanical Reverse Engineering

- 3D scanning and manual measurements.
- Reproduction of CAD models from existing parts.
- Software: SolidWorks, Fusion360.

6. Security and Intrusion Detection

- RE in cybersecurity: malware detection, vulnerability analysis.
- Software signatures, protections against RE (obfuscation, encryption).

7. Case Studies

- Analysis of obsolete or unknown products (mouse, power supply, Bluetooth module, etc.).
- Reverse engineering of mechanical parts or simple systems (fan, casing, etc.).

Practical Work Examples (Across 4 Engineering Disciplines)

- **Electrical Engineering**
  - Reverse engineering of an electrical device without schematic.
  - Examples: timer relay, electrical panel, variable speed drive, electric machine, automation system.
  - Objectives: identify function, draw schematic, propose improvements.
  - Component identification (ICs, transistors, resistors, capacitors, etc.).
  - Tools: multimeter, oscilloscope, logic analyzer.
  - Firmware reading and extraction from microcontrollers.
  - Introduction to electronic counterfeiting detection.

- **Mechanical Engineering**
  - Reverse engineering of a simple mechanism.
  - Examples: hand pump, torque wrench, mini press.
  - Mechanical disassembly of systems (pump, gears, cylinder, etc.).
  - Measurements and reconstruction of plans or 3D models using CAD software (SolidWorks, Fusion360).
  - Material identification and manufacturing methods.
  - Functional simulation from recreated model.

- **Civil Engineering**
- Analysis of existing structures without plans (walls, slabs, frameworks).
- Examples: metal stairs, window supports, formwork.
- Reverse engineering of structural elements.
- Material, assembly, and stress identification.
- Modeling using Revit, AutoCAD, or SketchUp.
- Study of rehabilitation or reproduction of historical structural elements.

- **Process Engineering**
- Reverse engineering of a laboratory module.
- Examples: instruments, distillation units, filtration units, exchangers, simple reactors.
- Analysis of existing industrial systems (distillation column, heat exchanger, reactor).
- Reconstruction of PFD and PID diagrams from observed installations.
- Identification of sensors, actuators, and control elements.
- Study of material and energy flows within a process.

Assessment Methods

- Technical laboratory work (practical sessions).
- Reverse engineering mini-project (report + oral defense).
- Final exam (multiple-choice questions + case study).
- Grading: Final exam 60%, Continuous assessment (labs/TP) 40%.

References / Bibliography

- Reverse Engineering for Beginners – Dennis Yurichev (gratuitenligne)
- The IDA Pro Book – Chris Eagle (logiciels)
- Practical Reverse Engineering – Bruce Dang
- Documentation :
  - https://ghidra-sre.org
  - https://www.kicad.org
  - https://www.autodesk.com/products/fusion-360

Semester: 3
Teaching unit: UET 2.1
Subject 1: Documentary research and dissertation design
VHS: 22:30 pm (Lecture: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:
Give the student the necessary tools to look for useful information in order to better use it in his or her end-of-studies project. Help them go through the different steps leading to the writing of a scientific document. To show them the importance of communication and to teach them to present the work done in a rigorous and educational way.

Recommended prior knowledge:
Methodology of writing, Methodology of presentation.

Material content:

Part I-: Documentary research:

Chapter I-1: Definition of the Subject **(02 weeks)**
- Subject Title
- List of keywords relevant to the topic
- 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 sources of information **(02 weeks)**
- Type of documents (Books, Theses, Dissertations, Periodical Articles, Conference Proceedings, Audiovisual Documents, etc.)
- Type of resources (Libraries, Internet, etc.)
- Assess the quality and relevance of information sources

Chapter I-3: Locate documents **(01 Week)**
- Research techniques
- Search operators

Chapter I-4: Processing information **(02 weeks)**
- Work organization
- The initial questions
- Summary of the selected documents
- Links between different parties
- Final plan of the literature search

Chapter I-5: Presentation of the bibliography **(01 Week)**
- The systems of 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: Outline and stages of the thesis **(02 weeks)**

- Identifying and Defining the Subject (Summary)
- Problem and objectives of the dissertation
- Other useful sections (Acknowledgements, Table of Abbreviations, etc.)
- The introduction (*The writing of the introduction last)*
- State of the specialized literature
- Formulating the hypotheses
- Methodology
- Results
- Discussion
- Recommendations
- Conclusion and outlook
- The Table of Contents
- Bibliography
- Appendices

Chapter II-2: Writing techniques and standards **(02 weeks)**

- Formatting. Numbering of chapters, figures and tables.
- The cover page
- Typography and punctuation
- The editorial staff. Scientific language: style, grammar, syntax.
- Spelling. Improved general language proficiency in comprehension and expression.
- Backup, 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 thesis

Chapter II-5: How to Avoid Plagiarism ? **(01 Week)**

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

- The quote
- Paraphrasing
- Indicate the complete bibliographic reference

Method of evaluation:

Review: 100%

References:

1. *M. Griselin et al., Guide de la communication écrit, 2nd edition, Dunod, 1999.*
2. *J.L. Lebrun, Guide pratique de rédaction scientifique: comment écrire pour le lecteur scientifique international, Les Ulis, EDP Sciences, 2007.*
3. *Has. Mallender Tanner, ABC de la rédaction technique: modes d'emploi, instructions d'utilisation, aides en ligne, Dunod, 2002.*
4. *M. Greuter, Bien rédaction son mémoire ou son rapport de stage, L'Etudiant, 2007.*
5. *Mr. Boeglin, reading and writing at university. From the chaos of ideas to the structured text. L'Etudiant, 2005.*
6. *M. Beaud, l'art de la thèse, Editions Casbah, 1999.*
7. *M. Beaud, l'art de la thèse, La découverte, 2003.*
8. *M. Kalika, Le mémoire de Master, Dunod, 2005.*

Proposal of some discovery materials

Master's Degree: Electrical Networks

Semester:...
UE Discovery Code: UED ....
Material :Electromagnetic compatibility
VHS: 22:30 pm (Lecture: 1h30)
Credits:1
Coefficient :1

Teaching objectives

The objective of the course is to apply electromagnetic field theory to electromagnetic pollution problems in the technological environment. At the end of the course, students will be able to have a global approach to an electromagnetic compatibility problem between the disturber and the disturbed, to look for all the potential causes of disturbances in a given environment, and to choose an optimal protection technique on the basis of theoretical studies.

Recommended Prior Knowledge

Basic notions of mathematics, electromagnetism and electrical networks.

Content of the material:

1. EMC concept (1 week)
Terminology, context and issues. CMF actors (sources, victims and couplings).

2. Types and mode of coupling (2 weeks)
Types of coupling: Conduction, radiation and ionization, (Galvanic, inductive, capacitive).
Coupling modes: differential and common
Calculation methods and measurement methods.

3. Reduction of couplings (2 weeks)
Electromagnetic effect of conductors (resistance, inductance and capacitance); Equivalent coupling circuit. Methods of reducing couplings.

4. Coupled model of transmission lines (2 weeks
Transmission line parameters, solving coupling equations in the time and frequency domains. Coupling with shielded cables.

5. Disturbances generated with power transmission lines (1 weeks)
EM radiation of the busbars in LF (in a steady state of operation) and in a transient regime (interlocking of a line), Risk of disturbance of the measuring equipment – control and command.

6. Disturbances generated by electronic circuits (1 weeks)
Transmission by conduction and radiation of transient electrical quantities.

7. Disturbances generated by electrostatic discharge (2 weeks)
Phenomenology, lightning (description of cloud-to-ground lightning, Direct and indirect effects of lightning).

8. EMC protection techniques (1 week)
Ground, shielding, arrangement of components and wiring, ground-reducing effect, filtering and surge protection.

9. EMC Standards (1 week)
Current regulations

Evaluation method: 100% exam

References

1. P. DEGAUQUE and J. HAMELIN Electromagnetic compatibility - radio noises and disturbances, Dunod publisher
2. M. IANOVICI and J.-J. MORF: Presses Polytechniques Romandes
3. A. KOUYOUMDJIAN: Harmonics and electrical installations

4. R. CALVAS: Electrical disturbances in LV technical notebook n141

Master's Degree: Electrical Networks

Semester:...
UE Discovery Code: UED ....
Material: Propagation of electrical waves on the energy network
VHS: 22:30 pm (Lecture: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives

Master the modeling of internal and external disturbances in the power grid.

Recommended Prior Knowledge

Basics of Power Grids, Lines and Cables

Content of the material:

I. General equations of coupled lines,
- solution of the equations of the lines in the phase domain,- interconnected lines
- modal analysis, - solution of line equations in the domain of modes
- representation of a line by impedance matrix, - representation of a line by admittance matrix, - notions of impedance and reflection coefficients, - representation of a line by chain matrix (F), - representation of a line by matrix S

II. Calculation of linear parameters in LF and HF,
- an overhead multi-wire line whose return is made by a perfect ground or of finite conductivity,- a shielded cable buried in a perfect soil or of finite conductivity,
- an overhead shielded cable above a perfect ground or of finite conductivity,

III. Modeling a Multi-Wire Line
- Frequency modeling
- Temporal modeling

IV. General solution of the equations of the lines,
- in frequency
- in finite difference time (FDTD)

V. Topological formalism modeling of the propagation of an electric wave in a mesh network of lines or cables taking into account the conductivity of the ground.
- in frequency (RF signals)
- in time

Evaluation method

100% Review

References

1. Jean-Paul VABRE , Les lignes, Edition Ellipses, ISBN : 2 7298 9369 51993, 1993
2. C. R. Paul, "Analysis of Multiconductor Transmission Lines", a wiley-intersciencepublication, Copyright - 1994 by John Wiley & Sons, Inc.
3. Michel Aguet, Jean-Jacques Morf, Traité d'électricité: Energie électrique, Volume 12, Presses Polytechniques Romandes, 1981.
4. Michel Aguet and Michel Ianoz, High Voltage, PPUR - Collection: Traité d'Électricité – 2nd edition - 26/11/2004 (TE volume XXII).
5. Fred Gardiol, Electromagnetism, Treatise on Electricity, Volume 3: Presses Polytechniques et Universitaires Romandes (PPUR) (May 29, 2002)

Master's Degree: Electrical Networks

Semester:...
UE Discovery Code: UED ....
Subject: Introduction to Software Engineering and the Expert System
VHS: 22:30 pm (Lecture: 1h30)
Credits:1
Coefficient :1

Teaching objectives

Understand the interest of using software in the field of engineering sciences and the intervention of an expert system for real-time decision-making.

Recommended Prior Knowledge

Some notions of programming.

Content of the material:

I . General equations of coupled lines,
A. Software Engineering

1. definition
2. Software Lifecycle
3. Steps
4. Models - Methods
5. Tools
6. Development and configuration
7. maintenance
8. Software mismatch to needs
9. Complexity
10. Operational safety
11. Example of power grid simulation software (Power World Simulator)

B. Expert System

1. Origin of Expert Systems
2. Role of an expert system in industry
3. Realization of an expert system.
4. Evolution of expert systems.

Method of evaluation:

100% Review

References

1. Jacques Printz. : Software engineering. Presses Universitaires de France, 2002.
2. Alfred Strohmeier and Didier Buchs. Software engineering: principles, methods and techniques.
3. Laurence Negrello,¨expert systems and artificial intelligence, Cahier Technique Merlin Gerin n°157.

Master's Degree: Electrical Networks

Semester..:
UE Discovery Code: UED ...
Subject: Industrial Ecology and Sustainable Development
VHS: 22:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives

Raise awareness of sustainable development, industrial ecology and recycling.

Recommended prior knowledge:

Content of the material:

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

Evaluation method:

Review: 100%.

References:

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

Master's Degree: Electrical Networks

Semester:..
UE Discovery Code: UED ..
Subject: Industrial Computing
VHS: 22:30 pm (Lecture: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

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

Recommended prior knowledge:

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

Material content:

Chapter 1: Introduction to Industrial IT; **(02 weeks)**

Chapter 2: Hardware connection 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 DAC devices; **(02 weeks)**

Evaluation method:

Review: 100%

References:

1. Baudoin, Geneviève &Virolleau, Férial, "Les DSP famille, TMS 320C54X [texte imprimé]: développement d'applications", Paris: Francis Lefebvre, 2000, ISBN: 2100046462.
2. Pinard, Michel, "Les DSP, famille ADSP218x [texte imprimé]: principes et applications", Paris: Francis Lefebvre, 2000, ISBN: 2100043439;
3. Tavernier, Ch., "Les microcontrollers PIC: applications", Paris: Francis Lefebvre, 2000, ISBN: 2100059572;
4. Tavernier, Ch., "Les microcontrollers PIC: description et mise en œuvre", Paris: Francis Lefebvre, 2004, ISBN: 2100067222;
5. Cazaubon, Christian, "Les microcontrollers HC11 et leur programmation", Paris: Masson, [n.d], ISBN: 2225855277;
6. Tavernier, Christian, "Les microcontrollers AVR: description et mise en œuvre", Paris: Francis Lefebvre, 2001, ISBN: 2100055798;
7. Dumas, Patrick, "Industrial Computer Science: 28 Practical Problems with Course Reminder", Paris: Francis Lefebvre, 2004, ISBN: 2100077074.

Master's Degree: Electrical Networks

Semester:..
UE Discovery Code: UED ..
Material: **Materials in electrical engineering**
VHS: 22:30 pm (Lecture: 1h30)
Credits: 1
Coefficient: 1

Objectives:

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

Prerequisites: Fundamental physics and applied mathematics.

Content:

I. Knowledge and understanding of the operation, constitution, technology and specification of electrical equipment used in electrical systems.

II. Magnetic materials: properties, losses, types, thermal and mechanical properties, characterization, magnets, applications.

III. Conductive materials: properties, losses, insulation, tests and applications.

IV. Dielectric materials: properties, losses, breakdown and performance, stresses, tests and applications.

Evaluation method;
Continuous control: 40%; Examination: 60%.

References:

[1] A.C. Rose-Innes and E.H. Rhoderick, Introduction to Superconductivity, Pergamon Press.
[2] P. Tixador, Les superconductors, Editions Hermès, Collection matériaux, 1995.
[3] P. Brissonneau, Magnetism and Magnetic Materials, Hermès Editions.
[4] P. Robert, Matériaux de l' Electrotechnique, Volume II, Traité d'Electricité, d'Electronique et d'Electrotechnique de l'Ecole Polytechnique Fédérale de Lausanne, Edition Dunod.
[5] Techniques de l'Ingénieur.
[6] R. Coelho and B. Aladenize, Les diélectriques, Traité des nouvelles Technologies, série Matériaux, Editions Hermès, 1993.
[7] M. Aguet and M. Ianoz, High Voltage, Volume XXII, Traité d'Electricité, d'Electronique et d'Electrotechnique de l'Ecole Polytechnique Fédérale de Lausanne, Edition Dunod.
[8] C. Gary et al, The Dielectric Properties of Air and Very High Voltages, Collection de la Direction des Etudes et Recherches d'Electricité de France, Edition Eyrolles, 1984.
[9] Dielectric Materials for Electrical Engineering, Volume 1 & 2, HERMES LAVOISIER, 2007.

Master's Degree: Electrical Networks

Semester:..
UE Discovery Code: UED ..
Material: **Maintenance and dependability**
VHS: 22:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Content of the material:

I-History, context and definitions of the SdF

II-Analysis of systems with independent components (-Modeling of the malfunction logic by fault trees, -Boolean qualitative and quantitative exploitation, -Limitations of the method)

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

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

V- Application of dependability methodologies (- reliability, maintainability, availability, safety)

VI- Reliability forecasting methodology (-Reliability forecasts, -Failure mode analysis, -Fault diagnosis and maintenance techniques)

Evaluation method: Continuous assessment40%, examination: 60%

Bibliographical references:

1. Patrick Lyonnet, "Ingénierie de la confiance", Edition TEC & DOC, Lavoisier, 2006.
2. Roger Serra, "Reliability and Industrial Maintenance", Course, Ecole de technologie supérieure ETS, Université de Québec, 2013.

David Smith, Reliability, Maintenance and Risk, DUNOD, Paris 2006.

Master's Degree: Electrical Networks

Semester:..
UE Discovery Code: UED...
Subject: Maintenance of electrical networks
VHS: 22:30 pm (lecture: 1 hour 30 minutes)
Credits: 1
Coefficient: 1

Teaching objectives

This subject aims to organize maintenance tasks and define the objectives of this discipline in the field of electrical system operation

Recommended prior knowledge:

General information on the Operational safety of electrical networks

Material content

I. General information on the maintenance concept

I-1 Origin of maintenance, transition from servicing to maintenance, I-2 Definition of the different types of maintenance, I-3 Transition to maintenance of electrical systems,

II. Preventive maintenance

II-1 Routine maintenance, II-2 Condition-based maintenance, a) Age-related, b) Conditionally appropriate

III. Reliability-based maintenance

III-1 Basic notion of calculating the reliability of an electrical system, III -2 Modeling, State spaces, Fault trees, III -2 Cases of multi-component systems, III -3 cases of multi-degraded systems

IV. Failure Mode, Effects and Criticality Analysis (FMEA)

IV-1 Functional analysis and expertise, IV-2 Evaluation of frequency of occurrence, severity and criticality, IV-3 Applicability of maintenance actions, IV-4 Maintenance plans

V. Maintenance of systems associated with multiple degradation processes

VI. Evaluation of maintenance costs

VII. Applications to electrical network equipment

Assessment method: Continuous assessment: 40%, Examination 60%

References

1. **IEEE/PES Task Force on Impact of MaintenanceStrategy on Reliability.** The present status of maintenancestrategies and the impact of maintenance onreliability. IEEE Trans. Pwr Syst., 2001, 16(4), 638–646.
2. **Tsai, Y. T., Wang, K. S., and Tsai, L. C.** A study ofavailability centered preventive maintenance for multicomponentsystems. Reliability Engng Syst. Saf., 2004, 84, 261–269.
3. **Chan, G. K. and Asgarpoor, S.** Optimum maintenancepolicy with Markov process. Elect. Pwr Syst. Res., 2006, 76, 452–456.
4. **FairouzIberraken, RafikMedjoudj, RabahMedjoudj and DjamilAissani:** Combining reliability attributes to maintenance policies to improve high-voltage oil circuit breaker performances in the case of competing risks. *Proceedings of the Institution of Mechanical Engineers, Part O: Journal of Risk and Reliability 1748006X15578572, first published on April 2, 2015 as doi:10.1177/1748006X15578572*
5. **FairouzIberraken, RafikMedjoudj, RabahMedjoudj, DjamilAissaniet Klaus Dieter Haim:** Reliability based preventive maintenance of oil circuit breaker subject to competing failure processes, International Journal of Performability Engineering Vol. 9, No. 5, September 2013, p.495- 504. © RAMS Consultants
6. **RabahMedjoudj, DjamilAissani, Ahmed Boubakeur and Klaus Dieter Haim,** Interruption modeling in electrical power distribution systems using Weibull-Markov model, Proceedings of the Institution of Mechanical Engineers (IMEchE), Part O: Journal of Risk and Reliability June 1, 2009 223: 145-157, doi:10.1243/1748006XJRR215.

Master's Degree: Electrical Networks

Semester:..
UE Discovery Code: UED...
Material: High-voltage electrical equipment
VHS: 22:30 pm (lecture: 1 hour 30 minutes)
Credits: 1
Coefficient: 1

Teaching objective:

This subject allows the student to have an idea of the electrical equipment used in high voltage (HVA and HVB) and more particularly HV circuit breakers because they play an important role in the protection of electrical transmission and distribution networks.

Chapter I: General information on HV electrical equipment (4 weeks)
The different types of HV switchgear, symbols, classification of HV switchgear (according to the destination, according to the voltage, according to the installation, according to the operating temperature), the assigned characteristics of the HV switchgear, The HV disconnector (head-end disconnector, pantograph disconnector, MALT disconnector), switches, contactors, fused circuit breakers, circuit breakers, surge arresters.
Chapter II: Establishment and Interruption of Short-Circuit Currents (4 weeks)
Establishment and Breaking of Short-Circuit Currents, Process of Breaking a Short-Circuit Current, Cutting by Electric Arc, Extinction Peak, Transient Restoration Voltage, Post-Arc Current, Terminal Fault (Single Phase and Three-Phase), First Pole Factor, Representation of Normalized TTR Waves, Near Line Fault, Determination of the Shape of the Line-Side TTR, Calculation of line-side TTR parameters, Critical line length, arcing modeling in an HV circuit breaker
Chapter III: Circuit breakers (4 weeks)
Definition, Classification according to the interrupting medium, General principle of operation of an HV circuit breaker, oil circuit breakers, compressed air circuit breakers, vacuum circuit breakers, SF6 circuit breakers, classification of circuit breakers according to use (line circuit breaker, reactor circuit breaker, generator circuit breaker), classification according to installation (outdoor, indoor), operating temperature, assigned characteristics of an HV circuit breaker (Rated Voltage, Rated Frequency, Short Allowable Current, Short-Circuit Breaking Capacity, Restoring Transient Voltage, Assigned Closing Capacity, Assigned Breaking Time, Assigned Sequence of Maneuvers), The Contact System.
Chapter IV: Testing of HV electrical equipment (3 weeks)
Standards associated with HV electrical equipment, HV electrical equipment testing, HV circuit breaker testing in an electrical network, HV circuit breaker testing in a high-power laboratory, Direct testing, Synthetic testing, Terminal fault testing, On-line near fault testing,

References:

1. D. Dufournet, "Electrical Interrupting Apparatus HV. Part 1", Technique de l'ingénieur, D 4-690, 2001;
2. S. Theoleyre, "Les techniques de coupure en TM", cahier technique schneider N° 193, 1998;
3. www.siemens.com/High-Voltage Circuit Breakers from 72.5kV to up 800kV;
4. B. de Metz-Noblat, F. Dumas, G. Thomasset, "Calcul des courants de court-circuit", cahier technique schneider N° 158, 2000;
5. L. Van der Sluis, "Transients in Power Systems," John Wiley & Sons, 2001;

6. D. Dufournet, "HV Electrical Interrupting Apparatus. Annexes", Technique de l'ingénieur, D4-696, 2001;
7. R.W.Alexander, D. Dufournet ,"Transient Recovery Voltage (TRVs) for High-Voltage Circuit Breakers";
8. AC High voltage circuit breakers, IEEE Switchgear Committee Denis Dufournet; Portland (Maine, USA), October 2017.

Master's Degree: Electrical Networks

Semester:..
UE Discovery Code: UED...
Subject: Electrical energy and buildings
VHS: 22:30 pm (lecture: 1 hour 30 minutes)
Credits: 1
Coefficient: 1

Teaching objectives:

To become familiar with the different sources of renewable energy and to provide the student with all the necessary tools to manage, design and exploit these energy resources, particularly in the building.

Recommended prior knowledge:

Fundamentals of electricity, basic knowledge of static converters, renewable energy sources, electrical energy networks , measuring and protection equipment.

Material content:

Chapter I: The energy-producing building (3 weeks)

Concept of the BEPOS positive energy building, structure of so-called passive buildings, i.e. their roofs, walls, windows, waterproofing, etc. etc. for the purpose of storing and releasing heat or producing electricity;

Chapter II Energy Storage Techniques (3 weeks)

Definition of the different storage techniques used in buildings, particularly small-scale ones (hydraulic storage "tank", electrochemical storage "batteries", etc.).

Chapter III: Power Optimization and Maximization (3 weeks)

Classic and intelligent: The P&O technique, incremental technique, neural networks and fuzzy logic... etc. ;

Chapter IV: Power Management (4 weeks)

- Analysis of the operating modes of power optimization and management algorithms, energy efficiency (calculation).
- Assess the building's energy needs and know how to propose an appropriate organizational chart for the proper management of the building's power;
- Define the different concepts of management strategy: rule-based, deterministic optimization methods, and stochastic optimization methods.

Chapter V: Smart Building: Definition and Design (2 weeks)

To give an overview to students on the design and implementation of power management techniques in smart buildings (real-time acquisition and implementation map), techno-economic data.

References

1. A. Garnier, "The Positive Energy Building", Eyrolles Edition, 2012;
2. K. Beddiar, J. Lemale, "Smart Building and Energy Efficiency", Dunod edition, 2016;

3. D. L. Ha, "An advanced energy management system in buildings to coordinate production and consumption", doctoral thesis, University of Grenoble, 2008;
4. R. M. Badreddine, "Optimized Energy Management for a Multi-Source Multi-Load Smart Building: Different Principles of Validation", PhD thesis, University of Grenoble, 2012;
5. R. M. Noël, "Electrical energy management in a tertiary sector", European University Editions, 2018.

Master's Degree: Electrical Networks

Semester:..
UE Discovery Code: UED...
Subject: On-board electrical networks
VHS: 22:30 pm (lecture: 1 hour 30 minutes)
Credits: 1
Coefficient: 1

Teaching objective:

An on-board electrical network (the case of the automobile, aviation, train, tramway, ship, etc.), as opposed to the public distribution network, is differentiated by a low short-circuit power and a supply of isolated systems. Even if the energy management in these systems is similar to that of large interconnected systems, their size and mass require more appropriate management (choice of the type of power supply (alternating or direct), voltage level to be applied, protection rules, architecture guaranteeing optimal supply on loads). This subject will allow students to assess the similarities and differences between these areas of mobility.

Recommended prior knowledge:

Knowledge of different energy sources, storage systems, AC and DC power grids, electromagnetic compatibility.

Material content:

Chapter I: On-board electrical networks and their evolution: (4 weeks)

- Specific case study: Cars, planes, ships, trams, industrial or island networks;
- Energy needs, evolution of on-board power, evolution towards more electric systems, etc.

Chapter II: Architecture and management of energy sources of different kinds: (4 weeks)

Structure and sizing of the electrical installation (power requirements, cable lengths,...), methods of distribution of electrical power, emergency energy systems (storage), etc.

Chapter III: Design of on-board electrical networks: (5 weeks)

Issues related to the use of HVDC and HVAC networks, Coupling between equipment and stability risk, protection against faults (choice of neutral regime and associated protections, selectivity of protections), voltage quality, management of transient regimes)

Chapter IV: Quality standards for on-board electrical networks: (2 weeks)

Electricity quality, harmonic problem.

References:

1. F. Barruel, "Analysis and Design of Embedded Electrical Systems. Application to aircraft on-board networks", doctoral thesis, Joseph Fourier University, 2005;
2. C. Baumann: "Architecture and management of a high-voltage continuous mesh network for aeronautics", PhD thesis, University of Toulouse, 2009;
3. G. Filliau, A. Bond, L. Maodier, "The all-electric ship: Propulsion and energy production", Technique de l'ingénieur, traité Génie électrique, D5-610, 2008;

4. K. Maalej, "Energy management methods for a hybrid electric vehicle and a battery electric vehicle using online mass estimation", thesis at the University of Quebec in Trois-Rivières, 2014;
5. M. Pacault, A. Bondu and, P. Letellier, "Electric Ship - Propulsion, Electrical Distribution and Energy Production", Technique de l'ingénieur, D5610, 2016.

Master's Degree: Electrical Networks

Semester:..
UE Discovery Code: UED...
Subject: Renewable Energies
VHS: 22:30 pm (lecture: 1 hour 30 minutes)
Credits: 1
Coefficient: 1

Teaching objectives:
To allow students to acquire theoretical knowledge about renewable energies: source of renewable energy sources, types of renewable energy conversion systems, and energy conversion for each renewable energy conversion system.

Recommended prior knowledge:
- The principles of thermodynamics,
- Heat transfer modes,
- The principles of fluid mechanics.

Content of the material:

Chapter I: General information on renewable energies.
- Renewable energy sources,
- Type of renewable energies.

Chapter II: Wind Conversion Systems.
- Introduction to the wind farm,
- Architecture of wind conversion systems,
- Energy potential and conversion.

Chapter III: Photovoltaic conversion systems.
- Introduction to the solar deposit.
- Principle of photovoltaic conversion (photovoltaic effect)
- Type of photovoltaic conversion systems.

Chapter IV: Thermal Conversion Systems.
- Solar thermal collectors.
- Solar thermal energy conversion.

Chapter V: Applications.
Evaluation method: Exam: 100%.

References:

- BentSorensen. Renewable Energy. Elsevier, UK, 2004.
- Multon et al, Aérogénérateurs électriques », Techniques de l'Ingénieur, Traité de Génie Electrique, 2004.
- Hau, Wind-Turbines, Springer, 2000.
- J.F. Manwell, J.G. McGowan and A,L. Rogers , Wind energy explained theory ,design and application, University of Massachusetts, Amherst, USA

- Gary L. Johnson, Wind energy systems, 2006
- R. Patel Mukund, Wind and solar power systems, Taylor & Francis, 2006.
- Anne Labouret, Michel Villoz, Energie solaire photovoltaïque, Dunod edition, 2005.
- T. Markvart and L. Caslaner. Practical hand book of photovoltaics: fundamentals and applications. Elsevier, UK, 2003.
- Luis Castaner and Tom Markvart, Practical Handbook of Photovoltaics: Fundamentals and Applications, , Edition: Elsevier Science Ltd, 2003.
- M. Tissot, "Le guide de l'énergie solaire et photovoltaïque", Eyrolles, 2008.
- *Beckman, W.A., Klein, S.A., Duffie, J.A., 1977, Solar Heating Design by the f-Chart Method, Wiley Interscience, N.Y*
- *Duffie, J.A. Beckman, W.A., 2006, Solar Engineering and Thermal Process, John Wiley & Sons, third Ed., N.Y*