COMILLAS
UNIVERSIDAD PONTIFICIA
ICAI ICADE CIHS

Syllabus
2025 - 2026

GENERAL INFORMATION

Data of the subject	
Subject name	Power System Fundamentals
Subject code	DIE-GITI-201
Mainprogram	Bachelor's Degree in Engineering for Industrial Technologies
Involved programs	Grado en Ingeniería en Tecnologías Industriales [Second year]
Level	Reglada Grado Europeo
Quarter	Anual
Credits	12,0 ECTS
Type	Obligatoria (Grado)
Department	Department of Electrical Engineering

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DESCRIPTION OF THE SUBJECT

Contextualization of the subject

Prerequisites

There are not specific prerrequisites in this course

Course contents

Contents

Theory

1. Basic Concepts

Electric charge
Electric current
Voltage
Electrical resistance and conductance
Ohm's law
Power and energy
Joule's first law
Independent sources
Simple DC circuit

2. Basic DC circuit laws

Kirchhoff's Laws
Circuit elements
Series and parallel connection
Voltage and current sources
Series resistors and voltage division. Parallel resistors and current division
Source transformation

3. DC Circuit analysis

Nodes, branches, and loops
Basic circuit analysis
Branch current method
Mesh analysis
Nodal analysis
Special cases

4. Circuit theorems

Thevenin's and Norton's Theorems
Superposition theorem
Substitution theorem
Compensation theorem
Reciprocity theorem
Maximum power transfer theorem
Wye-Delta transformations

5. Circuits with dependent sources

Dependent sources
Special cases
Dependent sources equivalencies
Circuit analysis with dependent sources

6. Transient analysis of first-order circuits

Steady state and transient state
Response of first-order RL and RC circuits

7. AC Circuits

Sinusoids
Voltage and current in AC circuits
Voltage-current relationship in AC circuits. Resistors, inductors and capacitors
Electric power in AC circuits. Active, reactive, apparent, and complex power
Phasors
Phasor relationships for circuit elements Impedance and admittance.
Sinusoidal steady-state analysis
AC circuits with coupled inductors

8. Single phase elements

Resistors, capacitors and inductors
Quality factor and dissipation factor
Iron core inductor
AC Single phase generator
Single phase transformer
Single phase consumers
Power factor correction

9. Single phase systems

Overview of electric power system basics
Nominal data for electrical devices
Efficiency and regulation in transformers and lines
Electric power and energy measurement
Single phase system calculations
Per unit analysis for single phase systems

10. Balanced three-phase systems

Polyphase system
Symmetric three-phase system
Voltage and current in three-phase systems
Three-phase wye and delta configurations
Wye and delta configurations
Wye-Delta conversion
Three-phase electric power
Power and energy measurement in three-phase systems

11. Three-phase transformer

Fundamentals
Three-phase transformer connections
Nominal data of the three-phase transformer

12. Three-phase machines, lines and loads

Three-phase line
Synchronous machine
Asynchronous motor
Three-phase load

13. Balanced three-phase circuits analysis

Single-line diagram
Single-phase equivalent circuit
Per unit analysis for three-phase systems

14. Introduction to three-phase unbalanced systems

Unbalanced impedance loads in infinite bus
Power in unbalanced three-phase system

Laboratory
Laboratory sessions
1. Introduction to the laboratory 2. Assemblies and connections 3. Circuit laws 4. Thevenin's and Norton's theorems 5. Superposition and substitution theorems 6. AC Magnitudes 7. AC Circuits 8. Power measurement in single-phase circuits 9. Self-inductance and mutual inductance 10. Single-phase transformer 11. Power Measurement on four-wire systems 12. Power Measurement on four-wire systems

EVALUATION AND CRITERIA

The use of AI to produce full assignments or substantial parts thereof, without proper citation of the source or tool used, or without explicit permission in the assignment instructions, will be considered plagiarism and therefore subject to the University's General Regulations.

Evaluation activities	Evaluation criteria	Weight
Midterm exams, final term exams and quizzes	• Understanding concepts • Practical applications of electric circuits concepts • Written communication	80
Assistance and participation in the laboratory and preparation of laboratory reports	• Understanding concepts • Applications of electric circuits concepts in lab sessions • Teamwork skills • Written communication	20

Grading

- **Final mark**: 80% Theory + 20% Lab
- **Theory**: 60% final term exams (30%+30%); 25% midterm exams (12.5%+12.5%); 15% quizzes
- **Lab**: 30% preparation; 40% performance and attitude; 30% reports

In order to pass the course, a minimum mark of 5 out of 10 in each part (theory and lab) and a minimum mark of 3.5 out of 10 in the second final term exam are required.

Class attendance is mandatory according to Article 93 of the General Regulations (Reglamento General) of Comillas Pontifical University

and Article 6 of the Academic Rules (Normas Académicas) of the ICAI School of Engineering. Not complying with this requirement may have the following consequences: students who fail to attend more than 15% of the lectures may be denied the right to do the final exam (and even the retake exam)

AI planning

AI may be used for pre-tak activities such as brainstorming, outlining and initial research. This level focuses on the effective use of AI for planning, synthesis, and ideation, but assessment should emphasise the ability to develop and refine these ideas independently.

AI cannot be used in any exam or intermediate assessment test.

BIBLIOGRAPHY AND RESOURCES

Complementary references

- F. J. Chacón, Electrotecnia, Universidad Pontificia Comillas.
- J.W. Nilsson, S.A. Riedel. Circuitos eléctricos.(7ª Edición). Prentice Hall, 2005
- C. Alexander, M. Sadiku. Fundamentos de Circuitos eléctricos. McGraw-Hill
- F. J. Chacón, Medidas Eléctricas para Ingenieros, Universidad Pontificia Comillas.
- Moodle:
  - Ejercicios
  - Transparencias
  - Información general del laboratorio
  - Guiones de prácticas de laboratorio
  - Problemas de examen con solución

Power System Fundamentals 2º GITI 2025-2026

Teaching hours dedicated to each topic, including lecturing, solving problems and working quizzes. Midterm or final term exams and laboratory sessions are not included.	
1. Basic Concepts • Electric charge • Electric current • Voltage • Electrical resistance and conductance • Ohm's law • Power and energy • Joule's first law • Independent sources • Simple DC circuit	(4h)
2. Basic DC circuit laws • Kirchhoff's Laws • Circuit elements • Series and parallel connection • Voltage and current sources • Series resistors and voltage division. Parallel resistors and current division • Source transformation	(2h)
3. DC Circuit analysis • Nodes, branches, and loops • Basic circuit analysis • Branch current method • Mesh analysis • Nodal analysis • Special cases	(5h)
4. Circuit theorems • Thevenin's and Norton's Theorems • Superposition theorem • Substitution theorem • Compensation theorem • Reciprocity theorem • Maximum power transfer theorem • Wye-Delta transformations	(8h)
5. Circuits with dependent sources • Dependent sources • Special cases • Dependent sources equivalencies • Circuit analysis with dependent sources	(6h)
6. Transient analysis of first-order circuits • Steady state and transient state • Response of first-order RL and RC circuits	(5h)
7. AC Circuits • Sinusoids • Voltage and current in AC circuits • Voltage-current relationship in AC circuits. Resistors, inductors and capacitors • Electric power in AC circuits. Active, reactive, apparent, and complex power • Phasors • Phasor relationships for circuit elements Impedance and admittance. • Sinusoidal steady-state analysis • AC circuits with coupled inductors	(12h)

8. Single phase elements • Resistors, capacitors and inductors • Quality factor and dissipation factor • Iron core inductor • AC Single phase generator • Single phase transformer • Single phase consumers • Power factor correction	(13h)
9. Single phase systems • Overview of electric power system basics • Nominal data for electrical devices • Efficiency and regulation in transformers and lines • Electric power and energy measurement • Single phase system calculations • Per unit analysis for single phase systems	(6h)
10. Balanced three-phase systems • Polyphase system • Symmetric three-phase system • Voltage and current in three-phase systems • Three-phase wye and delta configurations • Wye and delta configurations • Wye-Delta conversion • Three-phase electric power • Power and energy measurement in three-phase systems	(7h)
11. Three-phase transformer • Fundamentals • Three-phase transformer connections • Nominal data of the three-phase transformer	(4h)
12. Three-phase machines, lines and loads • Three-phase line • Synchronous machine • Asynchronous motor • Three-phase load	(2h)
13. Balanced three-phase circuits analysis • Single-line diagram • Single-phase equivalent circuit • Per unit analysis for three-phase systems	(7h)
14. Introduction to three-phase unbalanced systems • Unbalanced impedance loads in infinite bus • Power in unbalanced three-phase system	(3h)