Syllabus
2025 - 2026

GENERAL INFORMATION

Data of the subject	
Subject name	Electric Machines
Subject code	DIE-GITI-312
Mainprogram	Bachelor's Degree in Engineering for Industrial Technologies
Involved programs	Grado en Ingeniería en Tecnologías Industriales y Grado en Administración y Dirección de Empresas [Third year] Grado en Ingeniería en Tecnologías Industriales [Third year]
Level	Reglada Grado Europeo
Quarter	Semestral
Credits	7,5 ECTS
Type	Obligatoria (Grado)
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Coordinator	FIDEL FERNANDEZ BERNAL
Schedule	to be assigned by teacher
Office hours	to be assigned by teacher

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Syllabus
2025 - 2026

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DESCRIPTION OF THE SUBJECT

Contextualization of the subject

Prerequisites

Basic knowledge of electromagnetism. Ability to solve A.C. electrical circuits.

In lab, basic knowledge of electrical safety, handling of measurement equipment, assembly of electrical schemes.

Handling of computer applications in engineering.

Course contents

Contents

THEORY

Unit 1: Extension of single-phase and three-phase transformers

Review of fundamentals of electromagnetic fields applied to electrical machines.

Basics of transformers: review of the physical model, electrical model, unit magnitudes, rating tests, vector group index.

Voltage drop analysis. Maximum value. Kapp approximation. Power factor effect. Typical values.

Short circuit current. Short-circuit power. Typical values. Electrodynamic effects.

Performance. Optimum degree of load and power factor. Typical values.

Management of catalogs and rating plate.

Basics of autotransformers.

Unit 2: Extension of fundamentals of rotating electrical machines

Types of rotating machines.

Operating principle of DC machines. Simplified model. Basic speed regulation. Torque.

AC machines. Revolving magnetic field. Induced electromotive force. Distributed and shortened windings. Multipolar machines.

Basic operating principles of the synchronous machine. Motor and generator working. Maximum torque. Construction types.

Basic working principles of squirrel cage induction machines. Construction types.

Unit 3: The induction machine

Equivalent circuit. Typical values.

Torque-slip curve. Operating modes. Torque-speed curve.

Management of catalogs and rating plate. Rating tests.

Start-up problem. Star-delta start. Starting by additional rotor resistance. Double cage and deep grooves rotor.

Single phase motor. Basic operation and starting methods.

Speed regulation through V/f control and application to soft start.

Unit 4: The synchronous machine

Equivalent circuit. Typical values. Rating tests.

Vector diagram of voltages and fluxes. Inductive and capacitive loads and magnetizing and demagnetizing effects.

Passive load operation: voltage and speed regulation. Operating curves.

Operation on infinite network: active and reactive power regulation. Mordey V curves. Operating PQ limits.

LAB

SE. Electrical safety. Electric current's effects. Protection measures. Safety rules.

T1. Three-phase transformer standard tests. Resistance measurement. No-load test. Short circuit test. Equivalent model.

T2. Autotransformer. Construction of an autotransformer. Resistive load test: voltage drop and performance.

A1. Asynchronous machine standard tests. Resistance measurement. No-load test. Locked rotor test. Equivalent L model.

A2. Load test of the asynchronous machine. Load test as motor and generator, with calibration of the auxiliary machine (DC machine). Performance by power balance.

S1. Synchronous machine standard tests. Resistance measurement. No-load test. Short circuit test. Equivalent model.

S2. The synchronous machine as generator on passive load. No regulation. Voltage regulation. Voltage & speed regulation.

S3. The synchronous machine as generator on an infinite network. Coupling of the synchronous machine to the electrical network. Active and reactive power control. Operation as synchronous compensator.

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
Exams • Mid-term exam. • Final exam.	• Concepts asimilation. • Applying concepts to the resolution of practical problems. • Results interpretation. • Written communication skill.	70
Experimental work evaluation	Lab experiences • Electrical assemblies and execution of standard tests. Use of measurement/control equipment. • Critical analysis of the results obtained in laboratory experiences. • Presentation and written communication. • Group work capacity. • Conscious and safety work in an electrical environment . Lab exam • Electrical assemblies and execution of standard tests. Use of measurement/control equipment. • Critical analysis of the results obtained in laboratory experiences. • Presentation and written communication.	30

Grading

Regular assessment

Final grade: 70% Theory + 30% Lab.

- **Theory** (out of 100%): 5% class grade, 5% class exam, 20% mid-term exam, 70% final exam.
- **Lab** (out of 100%): 50% lab experiences, 50% practical exam. Practical exam grade should be at least 5 to pass lab.

Theory and lab grades should be at least 5 to pass the subject.

Retakes

The student has two periods of final evaluation during one academic year. The first one will be carried out at the end of course (end of the semester). In case that Theory or Lab were not passed obtaining 5 or more points, the student has another opportunity of final evaluation at the end of the academic year. The dates of evaluation periods will be announced in the web page. The new grade will by obtained as follows:

Retake grade: 70% Theory + 30% Lab.

- **Theory** (out of 100%): 4.17% class grade, 4.17% class exam, 16.67% mid-term exam, 75% retake final exam.
- **Lab** (out of 100%): 50% lab experiences, 50% retake practical exam. Practical exam grade should be at least 5 to pass lab.

Theory and lab grades should be at least 5 to pass the subject.

Course rules

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 present the Theory or Lab final exams in regular assessment or retake period.

Students who commit an irregularity in any graded activity will receive a mark of zero in the activity and disciplinary procedure will follow (cf. Article 168 of the General Regulations (Reglamento General) of Comillas Pontifical University).

AI may be used to help complete the task, including idea generation, tasking, feedback, and refinement. **Students should critically evaluate and modify the AI suggested outputs, demonstrating their understanding.**

WORK PLAN AND SCHEDULE

Activities	Date of realization	Delivery date
Please, see document attached.		

BIBLIOGRAPHY AND RESOURCES

Basic References
• J. Fraile Mora, “Máquinas Eléctricas”. 7ª ed., Garceta, Madrid, 2015. ISBN 978-841622813

- J. Fraile Mora, “Problemas de Máquinas Eléctricas”. 2ª ed., Garceta, Madrid, 2015. ISBN 978-8416228140
- J. Sanz Feito, “Máquinas Eléctricas”. Prentice Hall, Madrid, 2002. ISBN 978-8420533919