ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA

DIE-GITI-201 Power System Fundamentals

SEMESTER: Annual (Fall and Spring)

CREDITS: 12 ECTS (4 hrs. per week: 3 Theory + 1 Lab, on average)

LANGUAGE: Spanish

DEGREES: GITI (Degree in Industrial Technology Engineering)

Course overview

This course is an introduction to power systems. By the end of the course, the student should be able to master the tools to analyze successfully DC circuits, single-phase and three-phase AC circuits.

Prerequisites

Basic knowledge of electricity and electromagnetics as well as complex numbers algebra.

Course contents

Theory:

1. **Introduction**. Electrical charge, current and voltage. Resistance: Ohm's Law. Electrical Energy and Power. Joule's Law. Electrical Generators.
2. **DC Circuits Fundamentals**. Kirchhoff's Laws. Circuit elements. Series and parallel connections. Two-port equivalences.
3. **DC Circuits Analysis**. Terminology: node, branch, loop, mesh. Solution techniques. The mesh-current method. The Node-voltage method.
4. **Circuit Theorems**. Superposition. Thévenin and Norton equivalents. Substitution, Compensation, Reciprocity and Kennelly theorems.
5. **Circuits with controlled sources**. Definitions and special cases. Two-port equivalences. Solution techniques.
6. **Introduction to Transient Response**. Definition. First order transients in DC electric circuits. Initial condition. Steady state. Time constant. General solution.
7. **AC Circuits**. Periodic functions. AC circuit elements: resistors, capacitors and inductors, voltage-current relationship. AC Power: real, reactive and apparent power. Phasors. Complex impedance and admittance. Complex power. Solution techniques.

8. **Basic elements in single-phase systems.** Non-ideal inductor and capacitor. Coupled Coils. Linear transformer. Introduction to electrical generator. Power factor improvement.

9. **Single-phase power systems.** Introduction to electric power generation, transmission, and distribution. Voltage regulation and efficiency of lines and transformers. Power and energy measurement. Per-unit calculations.

10. **Balanced three-phase power systems**. Multiphase circuits. Three-phase systems. Wye and delta connections. Phasor voltages and currents. Three-phase power. Power measurement.

11. **Three-phase transformer**. Three-phase transformer base values. Winding configurations. Vector group. Nameplate.

12. **Introduction to three-phase lines and three-phase rotating machines**. Three-phase lines parameters and models. Introduction to synchronous machines. Introduction to induction motors.

13. **Introduction to power system analysis.** Single-line equivalent circuit. Per-unit calculations.

14. **Introduction to unbalanced three-phase systems.** Unbalanced systems with an infinite bus. Power in unbalanced systems.

Laboratory:

There will be twelve 2-hour sessions, usually every two weeks during the whole year.

P1. Lab Introduction
P2. Circuits assembly and connection
P3. Circuits Laws
P4. Thévenin and Norton equivalents
P5. Superposition and Substitution Theorems
P6. AC Circuits
P7. Use of the oscilloscope to measure AC quantities
P8. Instantaneous, real and reactive power measurements in single-phase circuits
P9. Inductors self-inductance and mutual inductance
P10. Single-phase transformer. Open circuit and short circuit tests
P11. Real and reactive power measurement in four-wire three-phase circuits
P12. Power measurement in three-wire three-phase circuits (Aron method)
Lab Exam

Textbook

- F. Julián Chacón. Electrotecnia. Universidad Pontificia Comillas

Grading

A minimum grade of 5 over 10 in both parts of the course (Theory and Lab) must be obtained to pass the course.

The **Theory** part accounts for 80% of the grade and is obtained as follows:

- Final exam 55%
- Other exams 30%. One exam at the end of the Fall term and another two mid-term exams
- In-class short exams, tests and exercises 15%

The **Lab** part accounts for 20% of the grade and is obtained as follows:

- Lab exam 50%.
- Lab work 50%. It takes into account the preparation (15%), performance during the lab sessions (20%) and lab reports (15%)