PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE
COLLEGE OF ENGINEERING
DEPARTMENT OF ELECTRICAL ENGINEERING
ABET COURSE SYLLABI

# IEE2313 POWER SYSTEMS

**Credits and contact hours:** 10 UC credits/10 hours (3 hours Lecture hours per week and 7 hours of Independent learning experience per week)

**Instructor's name:** David Watts

**Course coordinator's name** Daniel Olivares

**Textbook:** Gómez Expósito, A., et al., "Análisis y Operación de Sistemas de Energía Eléctrica", Mc Graw Hill, 2002.

**Course Catalog Description:** This course provides students with the technical skills and conceptual framework to understand the operation principles of electric power systems and components. In specific, the course presents mathematical models, and qualitative and quantitative analysis methodologies to study the operation of power system under normal steady-state conditions, and in abnormal contingency situations. Economic aspects of the operation of power systems are also introduced.

**Prerequisite Courses:** IEE2123 Electrical Circuits

**Co-requisite Courses:** To be defined

**Status in the Curriculum:** Elective, 2009-2012 Admissions.
Required for Minor in Electric Energy, since 2013 Admission.

**Course Learning Outcomes:**

1. Understand the technical, economic, and regulatory frameworks of the operation of power systems, including the particular characteristics of generation, transmission and distribution sectors.
2. Analyze and apply basic power system modelling concepts, per-unit representation of the system, and the steady-state analysis of power system and components as two-port networks/elements.
3. Analyze and apply the concepts of security, reliability, and quality of service in power systems.
4. Apply numerical analysis techniques to the solution of the power flow problem, including Gauss, Gauss-Seidel, Newton, and Newton-Raphson algorithms.
5. Specify reactive power requirements and control settings to improve voltage regulation.
6. Understand the concept of marginal cost of production in power systems, and solve the economic load dispatch problem.
7. Analyze the operation of power systems during short circuit

conditions (e.g., three-phase fault, single-line to ground, open-phase,etc.) using the concept of symmetrical components.

8. Specify power system components and protection settings based on short circuit analysis.
9. Analyze the angle stability of power systems at an introductory level, using the equal-area criterion.
10. Understand the operation principles of generation units, and their operating chart.
11. Use computational tools (software) for the modelling and analysis of power systems operation, with emphasis on steady-state conditions.
12. Recognize the different power system components studied in the course in real-world transmission substations, and generation facilities.

**Relation of Course to ABET Criteria:**

a. Knowledge of mathematics, science and engineering.
b. Design a system, component, or process.
e. Identify, formulate, and solve engineering problems.
f. Professional and ethical responsibility.
h. Broad education necessary for global, economic, environmental and societal context.
j. Knowledge of contemporary issues.
k. Techniques, skills, and modern tools for engineering practice.

**Topics covered:**

1. <u>Introduction:</u> Deregulation in the electric power sector. General description of the electric power systems: generation, transmission, distribution. Characteristics of system components.
2. <u>Basic concepts:</u> Per-unit system representation, modeling, two-port networks, ABCD parameters.
3. <u>Power Systems:</u> Security, reliability, and quality of service. Steady-state analysis: Power flow analysis (Gauss-Seidel and Newton-Raphson methods). Voltage regulation and reactive power control methods. Economic load dispatch in thermal systems. Analysis of abnormal conditions: Shunt and series faults. Symmetrical components, sequence networks, network interconnection and typical calculations. Basic concepts of stability and the application of the Equal Area Criteria.
4. <u>Components:</u> Transmission lines (parameters, representation, equivalent circuits), Transformers (models, zero-sequence representation). Synchronous generators (Operating chart).