Electric Power Systems

Academic Year: (2023 / 2024) **Review date: 29/01/2024 17:30:44**

Department assigned to the subject: Electrical Engineering Department

Coordinating teacher: MORENO LOPEZ DE SAA, MARIA ANGELES

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

- Electrical Power Egineering Fundamentals
- Magnetic Circuits and Transformers
- Transmission Lines and Electrical Equipment

LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
COCIN4. Ability to resolve problems with initiative, decision-making, creativity, and critical reasoning skills and to communicate and transmit knowledge, skills and abilities in the Industrial Engineering field.
COCIN5. Knowledge to perform measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and other similar jobs.
CEP2. Knowledge and ability to apply computational and experimental tools for analysis and quantification of electrical engineering problems.
CEB1. Ability to solve the mathematic problems arising in engineering. Aptitude for applying knowledge of: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and partial derivatives: numerical methods; numerical algorithms, statistics and optimization.
CEB3. Basic knowledge of the use of computer programming, operating systems, databases, and computer programs with engineering applications.
ECRT6. Knowledge of electrical power systems and applications.

By the end of this content area, students will be able to have:
RA1.3. Coherent knowledge of the branch of electrical engineering including some at the forefront of their branch in electric power systems.
RA2.1. The ability to apply their knowledge and understanding to analyse engineering products, processes and methods.
RA2.3. The ability to select and apply relevant analytic and modelling methods in electric power systems.
RA3.2. An understanding of design methodologies for electric power systems, and an ability to use them.
RA4.1. The ability to conduct searches of literature, and to use data bases and other sources of information.
RA5.3. An understanding of applicable techniques and methods in electric power systems, and of their limitations.
RA5.4. An awareness of the non-technical implications of engineering practice.

OBJECTIVES

The student will be able of analysing electric power systems in steady-state conditions, using using basic tools as per-unit quantities and load flow
algorithms, and also under fault conditions (symmetrical and unsymmetrical).

The student will acquire basic knowledge about the transient stability problem and the capability to analyse the transient stability in simple cases. The student will acquire basic skills in using commercial software for power system analysis.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to the electric power systems.
- Structure of a power system.
- Per-unit quantities.

2. Load flow studies.
- Problem description. Buses types.
- The Newton-Raphson method.
- Decoupled methods: Fast decoupled method and DC power flow.
- Control of power into a network.

3. Symmetrical three-phase faults.
- Transients in RL series circuits.
- Short-circuit power.
- Short-circuit currents and the reactances of synchronous machines.
- Internal voltages of loaded machines under transient conditions.
- The Bus Impedance Matrix in fault calculations.

4. Symmetrical components.
- The symmetrical components of unsymmetrical phasors.
- Symmetrical components of phase and line currents and voltages.
- Power in terms of symmetrical components.
- Sequence impedances and sequence networks.

5. Unsymmetrical faults.
- Unsymmetrical faults in power systems.
- Interconnection of Sequence networks in a single line-to-ground fault.
- Interconnection of Sequence networks in a double line-to-ground fault.
- Interconnection of Sequence networks in a line-to-line fault.
- Analysis of unsymmetrical faults using the bus impedance matrix.

6. Power system transient stability.
- The stability problem. Transient stability studies.
- The swing equation.
- The power-angle equation.
- Equal-area criterion of stability.
- Factors affecting transient stability

Computer sessions:
1. Power flow study within PSS/E.
2. Power flow control within PSS/E.
3. Symmetrical and unsymmetrical faults analysis within PSS/E.

LEARNING ACTIVITIES AND METHODOLOGY

- Magisterial classes, tutorship and personal work oriented to the acquisition of theoretical knowledge. (3 ECTS credits)
- Problems solution classes, laboratory sessions, tutorship and personal work (problems and self-assesment quizzes) oriented to the acquisition of practical skills. (3 ECTS credits)

Additionally, collective tutorship can be included in the programme.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	0
% of continuous assessment (assigments, laboratory, practicals…):	100

CONTINUOUS ASSESSMENT (100%):
- Laboratory (LAB): 3 sessions with simulation software PSSE. Attendance in the computer lab sessions is compulsory for all new students.
- Quizzes (QZ): Online quizzes related to each topic and homework assignments.

% end-of-term-examination/test:	0
% of continuous assessment (assigments, laboratory, practicals…):	100

- Partial exam 1 (P1): Convers the first half of the program. A minimum score of 2 points (from 10) in each exercise is required.
- Partial exam 2 (P2): Convers the second half of the program. A minimum score of 2 points (from 10) in each exercise is required.

Continuous grade (CG): CG = 0.10·LAB + 0.15·QZ + 0.35·P1 + 0.40·P2

If CG >=5 and MIN(P1,P2) >= 4, the subject is passed and the Final Grade (FG) is CG.

Otherwise, the final grade (FG) depends on an end-of-term examination (EX). Continuous grade (CG) in this case consists of:
CG = 0.1·LAB + 0.1·QZ + 0.1·P1 + 0.1·P2.

- Ordinary Final Exam: FG = 0.6·EX + CG

- Extraordinary Final Exam: FG = MAX(0.6·EX + CG, EX)

BASIC BIBLIOGRAPHY

- Elgerd, O.I. Electric energy systems theory: an introduction, McGraw-Hill, 1982

- Gómez Expósito, Martínez Ramos, Rosendo, Romero, Riquelme Sistemas Eléctricos de Potencia. Problemas y ejercicios resueltos, Prentice Hall, 2003

- Stevenson, W.D. Elements of Power System Analysis, McGraw-Hill, 1982

ADDITIONAL BIBLIOGRAPHY

- Gómez Expósito, A. Electric energy systems: analysis and operation, CRC Press, 2009

- Kundur, P. Power System Stability and Control, McGraw-Hill, 1994

BASIC ELECTRONIC RESOURCES

- Mohamed A. El-Sharkawi . Electric energy : an introduction: https://bibliotecas.uc3m.es/permalink/f/1qk6at5/34UC3M_ALMA51257799900004213

- Ramana, N.V. . Power System Analysis: https://learning.oreilly.com/library/view/power-system-analysis/9788131755921/?ar=