Electric power systems

Academic Year: (2023 / 2024) **Review date: 07/06/2023 18:48:50**

Department assigned to the subject: Electrical Engineering Department

Coordinating teacher: MORENO LOPEZ DE SAA, MARIA ANGELES

Type: Electives ECTS Credits : 6.0

Year : Semester :

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.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG1. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering.
CG3. Ability to design a system, component or process in the field of Industrial Technologies to meet the required specifications
CG4. Knowledge and ability to apply current legislation as well as the specifications, regulations and mandatory standards in the field of Industrial Engineering.
CG5. Adequate knowledge of the concept of company, institutional and legal framework of the company. Organisation and management of companies.
CG6. Applied knowledge of company organisation.
CG8. Knowledge and ability to apply quality principles and methods.
CG9. Knowledge and ability to apply computational and experimental tools for the analysis and quantification of Industrial Engineering problems.
RA1. Knowledge and understanding: Have basic knowledge and understanding of science, mathematics and engineering within the industrial field, as well as knowledge and understanding of Mechanics, Solid and Structural Mechanics, Thermal Engineering, Fluid Mechanics, Production Systems, Electronics and Automation, Industrial Organisation and Electrical Engineering.
RA2. Engineering Analysis: To be able to identify engineering problems within the industrial field, recognise specifications, establish different resolution methods and select the most appropriate one for their solution
RA3. Engineering Design: To be able to design industrial products that comply with the required specifications, collaborating with professionals in related technologies within multidisciplinary teams.
RA4. Research and Innovation: To be able to use appropriate methods to carry out research and make innovative contributions in the field of Industrial Engineering.
RA5. Engineering Applications: To be able to apply their knowledge and understanding to solve problems and design devices or processes in the field of industrial engineering in accordance with criteria of cost, quality, safety, efficiency and respect for the environment.
RA6. Transversal Skills: To have the necessary skills for the practice of engineering in today's society.

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.
- 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). In this case, the continuous grade is formed as:
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=