Dynamical analysis and control of electrical systems

Academic Year: (2024 / 2025) **Review date: 14-05-2024**

Department assigned to the subject: Electrical Engineering Department

Coordinating teacher: LEDESMA LARREA, PABLO

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Basic theory of electric circuits.

OBJECTIVES

Generally, the student will be able to:
- Apply voltage and frequency control techniques to electric power systems.
- Perform basic power system studies similar to those carried out by system operators.
- Analyze the dynamic response of a power system.

More specifically, the student will adquire the following capabilities:
Recognize the agents of a power system involved in each control system.
Select the appropriate devices to solve voltage problems in an electric grid and to explain how they work.
Recognize the phenomena that can result in a voltage collapse.
Explain in detail the primary, secondary and tertiary frequency control systems.
Explain the load shedding and other load disconnection schemes in the peninsular power system.
Explain the behavior of the frequency control systems after different incidents in the power grid.
Select a power system analysis software tool depending on the type of study.
Explain the nature of electro-mechanical oscillations in a power system after a severe perturbation.
Analyze the results of a dynamic simulation such as the performed by the transmission system operators.

DESCRIPTION OF CONTENTS: PROGRAMME

1 Power system control and regulatory frame

2 Voltage control
- Reactive power control and voltage control
- Capacitors and inductors
- Synchronous compensators
- Static VAR compensators (SVCs)
- Static synchronous compensator (STATCOM)
- Tap change transformers
- Excitation systems
- Voltage control in the Spanish regulation
- Voltage stability

3 Frequency control
- Frequency control basics
- Primary control
- Secondary control
- Other mechanisms: terciary control, time control
- Energy reserves
- Frequency control in the Spanish regulation
- Load shedding and interruptilibity service

4 Transient stability
- Definition of transient stability
- Equal area criterion
- Power system dynamic response simulation

5 What will be power systems like in the future?

LEARNING ACTIVITIES AND METHODOLOGY

- Solution of practical problems (2 ECTS)
- Computer lab sessions. (0,5 ECTS)
- Tutory sessions. (0,2 ECTS)

Methodologies:
- Theory sessions in the classroom.
- Solution of practical problems.
- Reading and discussion of technical documents related to the course, available in Aula Global.
- Oral presentation of one topic related to power systems, chosen between a list provided by the teacher, with special emphasis on communication skills.
- Practical sessions with software PSSE.
- Tutory sessions.

ASSESSMENT SYSTEM

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

Continuous Assessment:
- Midterm exams
- Laboratory sessions
- Presentation in class

Ordinary call:
- Continuous assessment 40%
- Final exam 60%

To pass the course, it is necessary to do the lab sessions.

BASIC BIBLIOGRAPHY

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

- Pablo Ledesma Análisis Dinámico y Control de Sistemas Eléctricos, Universidad Carlos III de Madrid, 2020

ADDITIONAL BIBLIOGRAPHY

- Kwatny, Harry G. ; Miu-Miller, Karen Power System Dynamics and Control, Springer, 2016

- N. V. Ramana Power System Operation and Control, Pearson, 2010

- Paul M. Anderson A.A Fouad Power system control and stability, Institute of Electrical and Electronics Engineers , 1977

- Pota, Hemanshu Roy The Essentials of Power System Dynamics and Control, Springer, 2018

BASIC ELECTRONIC RESOURCES

- European Network of Transmission System Operators for Electricity . ENTSOE web page: http://www.entsoe.eu

- Red Eléctrica de España . Página web de Red Eléctrica de España: http://www.ree.es