# Transmission and distribution of energy

**Academic Year: ( 2022 / 2023 )** **Review date: 04-06-2021**

**Department assigned to the subject: Department of Electrical Engineering**

**Coordinating teacher: LEDESMA LARREA, PABLO**

**Type: Electives ECTS Credits : 6.0**

**Year : 4 Semester :**

## REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Solution of AC electrical circuits using phasors (e.g. Electrical Power Engineering Fundamentals in UC3M)

## OBJECTIVES

By the end of the term, students will be able to:

1. Know and understand the scientific and mathematical principles underlying the analysis and design of power systems
2. Understand the key aspects and concepts of power system operation
3. Apply their knowledge and understanding to identify, formulate and solve power system problems using established methods
4. Apply their knowledge and understanding to design power systems that meet specified requirements
5. Demonstrate computer skills applying software tools to the analysis of power systems
6. Combine theory and practice to solve power system problems

## DESCRIPTION OF CONTENTS: PROGRAMME

Transmission and distribution grids
- Transmission voltages
- Meshed and radial grids
- Power quality
- Basic mathematical models of lines, transformers, loads and generators
- Per unit quantities

Power lines
- Mathematical models of a line
- Power flow and voltages in a line
- Conductors
- Insulators
- Pylons
- Corona effect

The power flow problem
- Power flow equations
- Newton-Raphson method
- Modified N-R methods

Voltage control
- Shunt-connected reactors and capacitors
- Automatic voltage regulation in power plants
- Tap changer transformers
- Ferranti effect
- Voltage control in a transmission system
- Voltage control in a distribution system

Substations
- Disconnectors
- Circuit breakers
- Substation configurations

Frequency control
Primary regulation
Secondary regulation
Tertiary regulation
Time control

Protection systems
Contingency analysis
Characteristics of a protection system
Short circuit current
Fault clearing time and transient stability

Emerging technologies in power systems
Energy load management
Electric vehicles
Smart meters
Smart grid

## LEARNING ACTIVITIES AND METHODOLOGY

Half the time is dedicated to practical sessions in a computer laboratory, most of them with software PSSE. PSSE is used by the Spanish Transmission System Operator and by many electrical utilities to represent the electrical network.

Also:
Theoretical classes
Solution of practical problems in class
Individual tutorial sessions

## ASSESSMENT SYSTEM

The continuous assessment will take into account:
- Assignments
- Quizzes
- Attendance and participation

Ordinary call:
If the grade of the continuous assessment is higher than 6/10, it is not necessary to take the final exam, and the continuous assessment is 100% of the grade.
Otherwise,
- Continuous assessment 40%
- Final exam 60%

Extraordinary call:
- Final exam 100%

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

## BASIC BIBLIOGRAPHY


- Grainger, Stevenson Power System Analysis, McGraw-Hill.
- P. Kundur Power System Stability and Control, EPRI.
- Pieter Schavemaker; Lou van der Sluis Electrical Power System Essentials, John Wiley & Sons, 2008


## BASIC ELECTRONIC RESOURCES

- . European Network of Transmission System Operators for Electricity: https://www.entsoe.eu