Transmission and distribution of energy

Academic Year: (2023 / 2024) **Review date: 12-02-2024**

Department assigned to the subject: Electrical Engineering Department

Coordinating teacher: LEDESMA LARREA, PABLO

Type: Electives ECTS Credits : 6.0

Year : Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

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

SKILLS AND 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.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG2. Learn new methods and technologies from basic scientific and technical knowledge, and being able to adapt to new situations.
CG3. Solve problems with initiative, decision making, creativity, and communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the engineering activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG4. Solve mathematical, physical, chemical, biological and technological problems that may arise within the framework of the applications of quantum technologies, nanotechnology, biology, micro- and nano-electronics and photonics in various fields of engineering.
CG5. Use the theoretical and practical knowledge acquired in the definition, approach and resolution of problems in the framework of the exercise of their profession.
CG6. Develop new products and services based on the use and exploitation of new technologies related to physical engineering.
CG7. Undertake further specialized studies, both in physics and in the various branches of engineering.
CE6. Solve problems of applied thermodynamics, heat transmission and fluid mechanics in the field of engineering.
CE20. Understand and address the general problems of the field of Energy, as well as the scientific and technological foundations of its generation, conversion, transport and storage.
CT1. Work in multidisciplinary and international teams as well as organize and plan work making the right decisions based on available information, gathering and interpreting relevant data to make judgments and critical thinking within the area of study.

RA1. To have acquired sufficient knowledge and proved a sufficiently deep comprehension of the basic principles, both theoretical and practical, and methodology of the more important fields in science and technology as to be able to work successfully in them.
RA2. To be able, using arguments, strategies and procedures developed by themselves, to apply their knowledge and abilities to the successful solution of complex technological problems that require creating and innovative thinking.
RA3. To be able to search for, collect and interpret relevant information and data to back up their

conclusions including, whenever needed, the consideration of any social, scientific and ethical aspects relevant in their field of study.
RA4. To be able to successfully manage themselves in the complex situations that might arise in their academic or professional fields of study and that might require the development of novel approaches or solutions.
RA6. To be aware of their own shortcomings and formative needs in their field of specialty, and to be able to plan and organize their own training with a high degree of independence.

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

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

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%

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