Nuclear energy

Academic Year: (2024 / 2025) **Review date: 24-04-2024**

Department assigned to the subject: Thermal and Fluids Engineering Department

Coordinating teacher: VENEGAS BERNAL, MARIA CARMEN

Type: Electives ECTS Credits : 6.0

Year : Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Calculus I, II, III
Physics I, II
Chemical Fundaments of Engineering
Writing and Communication Skills
Programming
Thermal Engineering
Engineering Fluid Mechanics
Heat power plants
Aero-thermochemical Systems

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

Upon successful completion of this course, students will be able to:
1.- know and understand the scientific principles underlying nuclear energy;
2.- apply their knowledge and understanding to identify, formulate and solve problems related to nuclear energy using established methods;
3.- apply their knowledge and understanding to develop and realise designs of systems or components to meet specified requirements;
4.- conduct searches of literature, and to use data bases and other sources of information;
5.- select and use appropriate equipment, tools and methods;
6.- function effectively as an individual and as a member of a team;
7.- use diverse methods to communicate effectively with the engineering community and with society at large;
8.- demonstrate awareness of the health, safety and legal issues and responsibilities of nuclear energy use, the impact of solutions in a societal and environmental context, and commit to professional ethics, responsibilities and norms of nuclear energy use.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction
1.1. History of nuclear energy and its contribution to the electric generation in Spain and the world.
1.2. Nuclear physics and radioactivity.
1.3. Kinetics, dynamics and thermohydraulics of the reactor.
2. Thermodynamic cycles and components of nuclear power plants (NPP)
2.1. Types of NPP.
2.2. Thermodynamic cycles of NPP.
2.3. Reactor, turbines, humidity separators, condenser, pumps, feedwater heaters, etc.
3. Fuel and nuclear safety
3.1. Production and cycle of nuclear fuel.
3.2. Control and safety systems of NPP.
4. Radiologic protection and waste management
4.1. Ionizing radiations and measurement systems.
4.2. Equipment and systems for radiologic protection.
4.3. Classification and management of radioactive wastes.
4.4. Dismantling of nuclear power plants. Spanish case.
4.5. Socioeconomics and environmental aspects.
5. Other developments
5.1. Current developments of NPP.

LEARNING ACTIVITIES AND METHODOLOGY

The learning methodology includes:
(1) Lectures covering the topics described within the course outline. To facilitate the sessions, the students will have available the lecture's slides as well as reference books to complete their learning.
(2) Solving problem sessions, where some issues are addressed from a practical point of view.
(3) Exercises solved by the student to self-assess their knowledge and to acquire the necessary abilities.
(4) Practical works. Elaboration of reports presenting the results obtained using computer software. The

capacity of the students to present and discuss clearly and concisely the results will be evaluated.

ASSESSMENT SYSTEM

% end-of-term-examination:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

ORDINARY CALL:
Continuous evaluation (50% of the final mark) + Final exam (50% of the final mark).
What does the continuous evaluation include?
- 2 partial exams (15% of the final mark each one)
- 3 computer labs (as total, 10% of the final mark). Attendance is compulsory. The reports delivered will be evaluated.
- 1 practical work (10% of the final mark). The report delivered and the oral presentation will be evaluated.

EXTRAORDINARY CALL:
There are 2 options, selecting that of the highest mark:
- Final exam: it represents 100% of the final mark.
- Similarly to the ordinary call: continuous evaluation (50% of the final mark) + final exam (50% of the final mark).

Contents of the partial and final exams:
- Practical problems covering the topics of the program.
- Short theoretical questions.
- Test quizzes.

BASIC BIBLIOGRAPHY

- C.F. Bowman, S.N. Bowman Thermal engineering of nuclear power stations: balance-of-plant systems, CRC Press, 2021

- CSN Las Centrales Nucleares Españolas, Consejo de Seguridad Nuclear, 1999

- Günter Kessler Sustainable and Safe Nuclear Fission Energy. Technology and Safety of Fast and Thermal Nuclear Reactors, Springer, 2012

- Igor L. Pioro Handbook of Generation IV Nuclear Reactors, Elsevier, 2016

- M.D. Carelli, D.T. Ingersoll Handbook of Small Modular Nuclear Reactors, Elsevier, 2015

- MIT The Future of Nuclear Power, Massachusetts Institute of Technology, 2003

- Neil E. Todreas, Mujid S. Kazimi Nuclear Systems. Volume I: Thermal Hydraulic Fundamentals, CRC Press, 2021

- R.E. Masterson Nuclear Engineering Fundamentals: A Practical Perspective, CRC Press, 2017

- Raymond L. Murray Nuclear energy: an introduction to the concepts, systems, and applications of nuclear processes. 6th ed. , Butterworth-Heinemann-Elsevier, 2009