COURSE DESCRIPTION CARD - SYLLABUS

Course name
Safety of nuclear power [S1Energ2>BEJ]

Course

Field of study
Power Engineering

Year/Semester
4/7

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
30

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
15

Number of credit points

5,00

Coordinators

prof. dr hab. inż. Janusz Wojtkowiak
janusz.wojtkowiak@put.poznan.pl

Lecturers

Prerequisites

Mathematics: algebra - functions, equations and inequalities, plane and space geometry, trigonometry, analytic geometry, basic probability theory, equations and systems of equations, elements of differential and integral calculus of functions of one variable at a level 6 PRK. Physics: fundamental lows of physics, rules of mass momentum and energy conservation in classical mechanics, statics, kinematics, dynamics, hydraulics and nuclear physics at level 6 PRK. Solving algebraic equations and systems of algebraic equations, formulating physical problems in the language of mathematics, solving simple differential equations, the use of integral calculus to calculate the geometrical quantities (eg, surface areas) and physical quantities (eg, average values of velocity, momentum of inertia), solving typical problems in classical mechanics - statics, kinematics, dynamics and hydraulics.

Course objective

Purchase by the students basic knowledge and skills in safety of nuclear power technology safety and security rules and risk assessment methodology.

Course-related learning outcomes

Knowledge:

1. The student knows the safety rules applied in the nuclear power industry.
2. The student knows the construction of the nuclear power plant safety systems and understands their operation.
3. The student has an elementary knowledge of the impact of a nuclear power plant on the environment during normal operation and in emergency situations.
4. The student has a basic knowledge of the reliability and safety of technical systems, and in particular about the probabilistic risk assessment methodology (PRA).
5. The student knows the types and properties of radiation and its effect on living organisms and material of structures.

Skills:
1. The student is able to estimate the reliability of a simple NPP safety system using the " event trees "or" fault trees "methodology.
2. The student is able to calculate the flow rate of water necessary for cooling turbine condensers during NPP normal operation and the water flow rate necessary to waste heat rejection in emergency situations.
3. The student is able to calculate, by using simplified methods, flow characteristics of emergency cooling systems of the NPP core.
4. The student is able to determine the temperature distributions in nuclear fuel during normal operation and in emergency situations.
5. The student can apply and convert units of physical quantities used in protection against radiation.

Social competences:
1. The student understands the need for teamwork in solving theoretical and practical problems.
2. The student understands the necessity of systematically deepening and expanding his competences.
3. The student is aware of the controversy of nuclear energy in individual and social perception.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lectures
A 60-minute written exam. Time of the exam and a full list of questions are specified and published at the beginning of the semester. The exam consists in answering 4 selected questions. In doubtful cases, the exam is extended by the oral part. Students' activity is assessed on each lecture.
Laboratory:
45-minute written final test in the last week of the semester. The test consists in solving 2 tasks.
Continuous evaluation of student progress on each tutorials.
Design (project)
Continuous evaluation on each class, discussion of student decisions and solutions Final presentation of the project and its defense by the student or students teams
Grading system: 0-9 points = 2,0 (failed); 10-12 points = 3,0 (sufficient); 13-14 points = 3,5 (sufficient plus); 15-16 points = 4,0 (good); 17-18 points = 4,5 (good plus); 19-20 points = 5,0 (very good)
In order to pass the exam there is necessary to obtain minimum 10 points. The tutorials is pass if the student gains at least 10 points.

Programme content

The module program covers the following topics:
1. safety strategy in nuclear energy,
2. thermal and flow calculations of nuclear power plant safety systems,
3. the impact of a nuclear power plant on the environment during normal operation,
4. threats from the NPP in emergency situations,
5. analysis of the causes and course of selected failures (accidents).

Course topics

The lecture program covers the following topics:
1. demand for water for cooling NPP turbine condensers,
2. residual heat and its removal,
3. functional system and safety system of the NPP,

4. emergency reactor shutdown systems,
5. emergency core cooling systems,
6. containment and its emergency systems.

The (computer) laboratory program covers the following topics:
1. calculations of emergency core cooling systems,
2. calculations of emergency containment systems,
3. calculations of the temperature distribution in nuclear fuel during an accident,
4. calculations of pressure changes in the primary circuit during a LOCA failure,
5. calculation of pressure changes in the containment during a LOCA failure.

The design exercise program covers the following topics:
1. preliminary design of a high-pressure emergency core cooling system,
2. preliminary design of a low-pressure emergency core cooling system,
3. preliminary design of the containment sprinkler system.

Teaching methods

Lectures
Lecture with multimedia presentation (including drawings, photos, animations). supplemented with examples considering different aspects of the issues presented, including: economic, environmental, legal and social.
Laboratory:
Solving sample tasks on the board, initiating discussions on solutions.
Design classes
Discussing typical cases, discussion of proposed assumptions and solutions, detailed evaluation of projects by the tutor, presentations by students, work in teams, developing students skills through activity-, project-, and problem-based (APPB) learning.

Bibliography

Basic:
1. Ablewicz Z., Dąbrowski W.B. Osłony przed promieniowaniem jonizującym. Arkady, W-wa 1986.
2. Ackermann G., Eksploatacja elektrowni jądrowych. WNT, W-wa 1987.
3. Hrynkiewicz Z. (Red.): Człowiek i promieniowanie jonizujące. PWN, W-wa, 2001.
4. Kiełkiewicz M. Jądrowe reaktory energetyczne. WNT, W-wa 1978.
5. Petrangeli G.: Nuclear Safety. 1st Ed. Butterworth-Heinemann, 2006
6. Elkmann P.:Emergency Planning for Nuclear Power Plants. CRC Press, 2009

Additional:
Murray R.L., Nuclear Energy (6th Ed.), Elsevier, Amsterdam 2009.

Breakdown of average student's workload

	Hours	ECTS
Total workload	132	5,00
Classes requiring direct contact with the teacher	62	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	70	2,50