INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Structural Mechanics			Field of study	Solid Mechanics and Structures										
Bachelor in	Mechanical Engineering			School	School of Technology and Management										
Academic Year	2023/2024	Year of study	3	Level	1-3	ECTS credits	6.0								
Type	Semestral	Semester	1	Code	9123-759-3102-00-23										
Workload (hours)	162	Contact hours	T -	TP 60	PL -	TC -	S -	E -	OT -	O -					

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s): Luís Manuel Ribeiro Mesquita

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Understanding the fundamental concepts of structural analysis.
2. Apply the Eurocodes and national regulations, used in the design of steel structures.
3. Design structural members and connections: tension members, compression members, beams and beam-columns; welded and bolted connections.
4. Acquire fundamental concepts on energy theorems.
5. Calculate the deflection of trusses, beams and frames using energy methods.
6. Use the force method to analyze statically indeterminate structures and to solve influence line problems.
7. Perform advanced structural analysis by hand and by computer software.
8. Interpret structural analysis results and write a detailed project report.

Prerequisites

Before the course unit the learner is expected to be able to:
1. Apply the concepts of differential and integral calculus.
2. Understand the concepts of Mechanics of Materials and Solids Mechanics.

Course contents

Introduction to the Structural Analysis and construction steelwork. Design Codes used for steel structures. Safety verification and quantification of actions. Ultimate limit states and Serviceability limit states. Energy methods applied to simple elements, trusses and frames. Strain energy. Influence lines. Statically indeterminate problems. Force method applied to the study of hyperstatic structures.

Course contents (extended version)

1. Introduction (1 week)
   - Types of structures: Continuous and framed.
   - Types of supports.
   - Superposition-of-effects principle.
   - Presentation and discussion of structural solutions.
2. Plastic Behaviour of Materials
   - Plastic deformation. Elastic-perfectly plastic material.
   - Plastic hinges and plastic moment. Collapse load in beams.
3. Design of steel structures
   - Eurocode 3 - design of steel structures. General rules and rules for buildings.
   - Safety verification using ultimate limit states. Cross section resistance and stability of members.
   - Design of bars, beams, columns.
   - Classification, quantification and combination of actions applied in building structures.
4. Plates
   - Classical plate theory.
   - Rectangular plates, Analytical methods: Navier and Levy.
   - Circular plates. Equilibrium equations, axisymmetric Bending.
5. Shells
   - Shells of revolution, membrane theory equilibrium equations.
   - Bending forces and moments in shells of revolution.
   - Simple design problems in pipes, tanks and pressure vessels.

Recommended reading

1. McCormac, Jack; Nelson, James; “Structural Analysis – A classical and Matrix approach”; Addison-Wesley, 2nd edition; 1997.
2. Graham W. Owens and Peter R. Knowles; The Steel Construction Institute; “Steel Designers Manual”; 5th edition; Blackwell Scientific Publications; 1992.
3. CEN, “EN 1993-1-1 - Eurocode 3, Design of Steel Structures – Part 1-1: General rules and rules for buildings”; May 2005.
4. A. C. Ugural. Stresses in plates and shells, McGraw-Hill, 1999.
5. S. P. Timoshenko, S. W. Krieger. Theory of plates and shells, McGraw-Hill, 1959.

Teaching and learning methods

This course has 60 tutorial hours in the semester. Two week lectures (two hours each) with theoretical exposition and practice, covering the resolution of problems given in class and the homework/self assignments. Students have to solve additional/proposed problems to gain the necessary knowledge of the course.

Assessment methods

1. Alternative 1 - (Regular) (Final)
   - Practical Work - 30%
   - Final Written Exam - 70%
2. Alternative 2 - (Student Worker) (Final)
   - Final Written Exam - 100%
3. Alternative 3 - (Regular, Student Worker) (Supplementary)
   - Practical Work - 30%
   - Final Written Exam - 70%
4. Alternative 4 - (Regular, Student Worker) (Special)
   - Final Written Exam - 100%

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation

Luís Manuel Ribeiro Mesquita	Debora Rodrigues de Sousa Macanjo Ferreira	João da Rocha e Silva	José Carlos Rufino Amaro
11-10-2023	19-10-2023	19-10-2023	31-10-2023