Course Unit	Option 2 - Structural Design		**Field of study**	Solids Mechanics and Structures
Master in	Mechanical Engineering		**School**	School of Technology and Management
Academic Year	2023/2024	**Year of study** 1	**Level** 2-1	**ECTS credits** 6.0
Type	Semestral	**Semester** 2	**Code**	5071-793-1203-01-23

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. Acquire fundamental concepts on energy theorems.
3. Calculate the deflection of trusses, beams and frames using energy methods.
4. Apply the Eurocodes and national regulations, used in the design of steel structures.
5. Design structural members.
6. Perform advanced structural analysis by hand and by computer software.
7. 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 structural Mechanics.

Course contents

Energy methods for analysis of structures. Statically undetermined problems.Design of steel structures: Criteria for safety and quantification of actions. ULS and SLS. Fundamental and accidental actions. Design of elements and structures. Instability problems in columns and beams. Buckling of elements in compression and bending. Industrial buildings design.

Course contents (extended version)

1. Energy Theorems (3 weeks)
   - Introduction to Energy Theorems. Strain energy and virtual work.
   - Theorem of virtual work.
   - Unit-load and unit-displacement theorems.
   - Displacements calculation using the theorem of virtual work. "Bonfim Barreiros Method".
   - Theorem of Castigliano. Theorem of Betti Maxwell's reciprocal theorem.
2. Statically indeterminate systems (2 week)
   - Presentation and systematization of the force method.
   - Matrix formulation of the force method.
   - Symmetry conditions. Continuous beams.
   - Structural hiperestaticity degree. Indeterminate trusses and frames.
   - Calculation of displacements in hyperstatic structures using the theorem of virtual work.
3. Design of steel structures (2 week)
   - Eurocode 3. Criteria for safety and quantification of actions. ULS and SLS.
   - Fundamental and accidental actions. Structural steel and connecting elements.
   - Design of isostatic elements and structures. Design of linear elements.
4. Instability problems in columns and beams. (3 week)
   - Buckling of elements under compression.
   - Buckling of elements under bending.
5. Industrial buildings design.

Recommended reading

1. McCormac, Jack; Nelson, James; "Structural Analysis – A classical and Matrix approach"; Addison-Wesley, 2nd edition; 1997.
2. Daniel L. Schodek, "Structures"; 4th edition; Prentice Hall, New Jersey, 2001.
3. Graham W. Owens and Peter R. Knowles; The Steel Construction Institute; "Steel Designers Manual"; 5th edition; Blackwell Scientific Publications; 1992.
4. CEN, "EN 1993-1-1 - Eurocode 3, Design of Steel Structures – Part 1-1: General rules and rules for buildings"; May 2005.
5. IPQ (2010). Eurocódigo 3 projeto de estruturas de aço Parte 1-8 projecto de ligações NP EN 1993-1-8: 2010. Caparica: IPQ.

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%

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Language of instruction

1. Portuguese
2. English

Electronic validation

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01-03-2024	04-03-2024	09-03-2024