INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Mechanics of Materials			Field of study	Solid Mechanics and Structures		
Bachelor in	Mechanical Engineering			School	School of Technology and Management		
Academic Year	2022/2023	Year of study	2	Level	1-2	ECTS credits	6.0
Type	Semestral	Semester	1	Code	9123-759-2104-00-22		

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): Paulo Alexandre Gonçalves Piloto

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Calculate internal actions and stresses in structural elements subject to axial, torsional, transverse and bending static loading.
2. Use the principles of equilibrium of forces and moments, to calculate stresses, strain and deflections in a range of components under various loading conditions.
3. Identify elastic mechanical properties and typical values of yield strength.
4. Analyse a wide range of problems in Mechanics of Materials by using suitable theoretical methods.
5. Use the techniques, skills and modern engineering tools necessary for engineering practice.
6. Study independently, use library resources and manage working time.

Prerequisites

Before the course unit the learner is expected to be able to:
1. Understand the fundamental principles of Maths and Physics.
2. Apply the concepts of Applied Mechanics I.

Course contents

Normal and shear stress. Deformation. Axial loading, Hooke's law, stress concentrations. Torsion in a circular and thin-walled hollow shafts, design of transmission shafts. Symmetric member in pure bending, eccentric axial loading, unsymmetrical bending and general case of loading. Design of beams for bending. Shearing stresses in common type beams and thin-walled members. Equation of the elastic curve, slope and deflection. Method of superposition. Statically indeterminate components.

Course contents (extended version)

1. Introduction and Concept of Stress
   - A short review of the statics methods.
   - Stresses in the members of a structure.
   - Analysis and design.
   - Axial loading. Normal stress.
   - Shearing stress. Shear stress in connections.
   - Bearing stress in connections.
   - Application to the analysis and design of simple structures.
   - Stress on an oblique plane under axial loading.
2. Stress and Strain, Axial Loading
   - Normal strain under axial loading.
   - Stress-Strain diagram. Modulus of Elasticity.
   - Deformations of members under axial loading.
   - Statically indeterminate problems.
   - Problems involving temperature changes.
   - Poisson's Ratio. Multiaxial loading; Generalized Hooke's Law.
   - Dilatation; Bulk Modulus. Shearing strain.
   - Further discussion of deformations under axial loading; Relation among E and G.
   - Stress-Strain relationships for fibber-reinforced composite materials.
   - Stress and strain distribution under axial loading; Saint-Venant's principle. Stress concentrations.
3. Torsion
   - Preliminary discussion of the stresses in a shaft.
   - Deformations in a circular shaft.
   - Stresses in the elastic range.
   - Statically indeterminate shafts.
   - Design of transmission shafts.
   - Stress concentrations in circular shafts.
   - Torsion of noncircular members.
   - Thin-Walled hollow shafts.
4. Pure Bending
   - Symmetric member in pure bending.
   - Deformations in a symmetric member in pure bending.
   - Stresses and deformations in the elastic range.
   - Deformations in a transverse cross section. Stress concentrations.
   - Eccentric axial loading in a plane of symmetry. Unsymmetrical bending.
   - General case of eccentric axial loading.
5. Design of Beams for Bending
   - Shear and bending moment diagrams.
   - Relations among load, shear, and bending moment.
   - Design of prismatic beams for bending.
6. Shearing Stresses in Beams and Thin-Walled Members
   - Shear on the horizontal face of a beam element.
   - Determination of the shearing stresses in a beam.
   - Shearing stresses in common types of beams.
   - Longitudinal shear on a beam element of arbitrary shape.
   - Shearing stresses in thin-walled members.
   - Unsymmetrical loading of thin-walled members.
7. Deflection of Beams
   - Deformation of a beam under transverse loading.
   - Equation of the elastic curve. Integration method.
   - Determine the slope and deflection of a beam.
   - Statically indeterminate beams.
   - Method of superposition.
8. Combined Loadings

Course contents (extended version)

- Stresses under combined loadings.
- Different applications in mechanical problems.

Recommended reading

1. Beer, F. P. & Johnston, E. R. , DeWolf J. T. , Mechanics of Materials, McGraw-Hill, 2002.
2. Riley, W. F. , Sturges L. D. , Morris D. H. , Statics and Mechanics of Materials, John Wiley & Sons, 2002.
3. Ugural, A. C. , Mechanics of Materials, McGraw-Hill, 1991.
4. Paulo J F Gomes, Resistência dos Materiais, ISBN 978-989-98697-0-7, 2015.

Teaching and learning methods

Methodologies: theoretical lessons with different methodologies presentation. Application of theoretical concepts in practical lectures through the problems resolution, given in class and homework. Resources: Software and testing in laboratory.

Assessment methods

1. Alternative 1 - (Regular, Student Worker) (Final)
   - Intermediate Written Test - 25%
   - Intermediate Written Test - 25%
   - Final Written Exam - 50%
2. Alternative 2 - (Regular, Student Worker) (Supplementary, Special)
   - Final Written Exam - 100%
3. Alternative 3 - (Student Worker) (Final, Supplementary, Special)
   - Final Written Exam - 100%

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation

Paulo Alexandre Gonçalves Piloto	Luís Manuel Ribeiro Mesquita	João da Rocha e Silva	Paulo Alexandre Vara Alves
28-09-2022	06-10-2022	07-10-2022	07-11-2022