30123 - Resistance of Materials

Información del Plan Docente

Academic Year	2017/18
Faculty / School	175 - Escuela Universitaria Politécnica de La Almunia 179 - Centro Universitario de la Defensa - Zaragoza
Degree	425 - Bachelor's Degree in Industrial Organisational Engineering 457 - Bachelor's Degree in Industrial Organisational Engineering 563 - Bachelor's Degree in Industrial Organisational Engineering
ECTS	6.0
Year	3
Semester	Second semester
Subject Type	Compulsory
Module	---

1.General information

1.1.Introduction

1.2.Recommendations to take this course

1.3.Context and importance of this course in the degree

1.4.Activities and key dates

2.Learning goals

2.1.Learning goals

2.2.Importance of learning goals

3.Aims of the course and competences

3.1.Aims of the course

3.2.Competences

4.Assessment (1st and 2nd call)

4.1.Assessment tasks (description of tasks, marking system and assessment criteria)

5.Methodology, learning tasks, syllabus and resources

5.1.Methodological overview

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Strong interaction between the teacher/student. This interaction is brought into being through a division of work and responsibilities between the students and the teacher. Nevertheless, it must be taken into account that, to a certain degree, students can set their learning pace based on their own needs and availability, following the guidelines set by the teacher.

The current subject (Strength of Materials) is conceived as a stand-alone combination of contents, yet organized into three fundamental and complementary forms, which are: the theoretical concepts of each teaching unit, the solving of problems or resolution of questions and laboratory work, at the same time supported by other activities

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The organization of teaching will be carried out using the following steps:

- **Theory Classes** : Theoretical activities carried out mainly through exposition by the teacher, where the theoretical supports of the subject are displayed, highlighting the fundamental, structuring them in topics and or sections, interrelating them.
- **Practical Classes** : The teacher resolves practical problems or cases for demonstrative purposes. This type of teaching complements the theory shown in the lectures with practical aspects.
- **Laboratory Workshop** : Practical activities will be implemented in the computer room 1.1 simulation software structures (Wineva 7.0 and Abaqus.cae) with the presence and teacher mentoring .
- **Individual Tutorials** : Those carried out giving individual, personalized attention with a teacher from the department. Said tutorials may be in person or online.

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The design of the learning process is based on adquiring theoretical knowledge, and specially in learning how to use it in practical situations. Therefore the teaching sessions have been programed to contain theory and practice through problem solving examples, videos or physical models. At every time the participation of the student is encouraged, since the more the student does, the more they learn.

5.2.Learning tasks

SPECIALIZATION IN BUSINESS Programmed learning activities	The programme offered to the student to help them achieve their target results is made up of the following activities... Involves the active participation of the student, in a way that the results achieved in the learning process are developed, not

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	taking away from those already set out, the activities are the following: • **Face-to-face generic activities** : **Theory Classes** : The theoretical concepts of the subject are explained and illustrative examples are developed as support to the theory when necessary. **Practical Classes** : Problems and practical cases are carried out, complementary to the theoretical concepts studied. **Laboratory Workshop** : This work is tutored by a teacher, in groups of no more than 20 students. • **Generic non-class activities** : Study and understanding of the theory taught in the lectures. Understanding and assimilation of the problems and practical cases solved in the practical classes. Preparation of seminars, solutions to proposed problems, etc. Preparation of laboratory workshops, preparation of summaries and reports. Preparation of the written tests for continuous assessment and final exams. The subject has 6 ECTS credits, which represents 150 hours of student work in the subject during the trimester, in other words, 10 hours per week for 15 weeks of class. A summary of a weekly timetable guide can be seen in the following table. These figures are obtained from the subject file in the Accreditation Report of the degree,

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	taking into account the level of experimentation considered for the said subject is moderate.

Activity	Weekly school hours
Lectures	3
Laboratory Workshop	1
Other Activities	6

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The activity program designed to learn this subject combines 1) class activities in the group and 2) non-presence activities:

1) The group activities will take place in the classroom or in a computer or materials laboratory, and there will be three kinds of sessions:

· Expository Classes.

These are theoretical and problem-solving classes, which allow to explain the concepts to the students and show them examples of strategies for solving practical cases. The whole group will be in the classroom. At the beginning of the theory sessions the professor will present the aim of the activity in the context of the course. Theoretical classes will be intercalated with problem-solving sessions, where the professor will illustrate the application of the basic concepts and will give general guidelines for problem-solving. The problems used to work in this kind of session will be selected from a collection that will be given to the students. Participation of the student will be encouraged in by scheduling the program of the session so that the students can work on the problems beforehand.

· Numerical Simulations and Tests in the Materials Laboratory .

The laboratory courses will take place in the computer room and in the soil laboratory of the Regiment of Pontoneros (Monzalbarba). The lab classes will take two periods and their distribution will be based on the time availability for every

class-section. Before the activity, the students will have a script where the motivation of the activity and a detailed protocol of what to do will be explained. The students will be distributed in teams of two members and will hand in a report containing the results obtained in the lab (or via simulations), and the answers to questions posed in the script. The students may be tested at the end of the session to evaluate their accomplishment. The lab grade will be determined from the test grade together with the report grade. The laboratory classes are compulsory activities to successfully pass the subject and their evaluation will contribute to the final grade.

· Tests .

At the end of every topic, the last 30 minutes of class will be spent making a test with a dual objective. First, students will be allowed to measure their achievements by facing a problem of similar complexity to the ones in the final exam. Second, students will be made familiar with the correction criteria of the professor. These tests will be graded in class by the students themselves or their classmates using a template prepared for the exercise. These grades will not contribute to the final evaluation.

2) The non-presence working hours will be invested in:

· Personal Learning and Homework .

The student is supposed to learn the basic theory, solve the collection of proposed exercises and hand-in the reports of the laboratory sessions. These activities are essential for the learning process of the student and to successfully comply with the evaluation activities. The best advice that can be given to the student is to work on the proposed exercises during the whole semester and seek help from colleagues or from a professor to solve problems that may have emerged.

· Tutorials .

The professor will be available during the semester for the students to come to the office and ask questions. In order to efficiently organize the tutorial sessions, the student will apply in class or by email for a tutorial session indicating their time availability. The professor will then agree with the student on a date, time and location for the tutorial session.

Observation and working closely with the student will allow orienting and steering the learning process adequately. The professor may give extra reinforcing work to the students if necessary; this extra work may consist of compulsory tutorials or solving additional exercises.

5.3.Syllabus

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Strength of Materials

Chapter 1: Introduction to Strength of Materials

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Types of Structures, links and loads

Balance and GDH a Structure

Definition and types of internal efforts

Calculation and Representation Efforts diagrams

Chapter 2: Structure Design Rigid Knots

Laminating criteria: voltage Von- Mises.

Normal stress distribution in a section

Distribution of shear stress one section

Bending and Twisting problems in structures

Chapter 3: Structure Design Articulated Knots

Method for calculating knots structures

PTV method to calculate displacements

Buckling phenomenon

Calculation of the truss structure

Chapter 4: Calculation of displacements in structures

Theorems Mohr (Gyre y Displacements)

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Virtual work (Gyre y Displacements)

Flexibility Method for Structural Analysis Hyperstatic

Chapter 5: Deformable Solid Mechanics: Stress- Strain

Deformable Solid Mechanics

Kinematics of Solid Deformable

Dynamics of Deformable Solid

Ratio behavior

Thermo- elastic behavior

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The contents of the course are organized according to the following index:

1. Introduction to Mechanics of Materials

1.1 Principles of Mechanics of Materials

1.2 Theoretical Model of an Elastic Solid

1.3 External and Internal Forces and Momenta

1.3.1 Static Equilibrium and Elastic Equilibrium. The Method of Sections

1.3.2 Internal Loadings. Normal and Shear Forces and Bending Moments and Torques

1.3.3 External Loadings. External Forces, Reactions and Connections

1.3.4 Statically Determinate and Indeterminate Systems

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1.4 Stress and Strain in Elastic Solids

1.4.1 Concept of Stress and Strain

1.4.2 Relationship between Stress and Strain. Stress-Strain Diagram

1.4.3 Elastic/Linear Regime. Hooke's Law and Poisson's Ratio

1.5 General Principles in Mechanics of Materials

1.6 Allowable Stress and Load. Security Coefficient

1.7 Strength Criteria. Equivalent Stress

2. Axially Loaded Members

2.1 Uniaxial Traction and Compression: Stress and Strain

2.1.1 Stress and Strain in Bars of Variable Section

2.1.2 Stress and Strain in Bars due to their Weight. Solids of Equal Strength

2.1.3 Stresses and Strains in Bars due to Temperature Changes

2.2 Strain Energy

2.2.1 Strain Energy due to Axial Load

2.3 Statically Indeterminate Structures

3. Bending of Beams

3.1 Introduction

3.1.1 Loads, Shear Forces and Bending Moments

3.1.2 Shear Force and Bending Moment Diagrams

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3.2 Pure Bending: Stress Analysis

3.3 Simple Bending: Stress Analysis

3.4 Deflection of Beams

3.4.1 Differential Equation of the Deflection Curve

3.4.2 Deflections by Integration of the Bending-Moment and Shear-Force Equations

3.5 Application in Simple Cases

3.5.1 Pinned Beam

3.5.2 Cantilever Beam

3.6 Method of Superposition

3.6.1 Tables of Deflections and Slopes of Beams

3.7 Composite Beams

3.7.1 Stress Analysis

3.8 Statically Indeterminate Beams

3.8.1 Solution based on the Defection Equation

3.8.2 Solution based on the Method of Superposition

3.8.3 Solution based on the Energy Theorems of Castigliano and Menabrea

3.9 Application of the Three Methods to One Beam

4. Buckling

4.1 Introduction. Strength, Stiffness and Stability

4.2 Buckling of Columns with Pinned Ends

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4.2.1 Differential Equation of the Column

4.2.2 Critical Load: Euler's Formula

4.3 Buckling of Columns with other Support Conditions

4.3.1 Columns with a Free End or Eccentric Axial Loads

4.3.2 Critical Loads and Effective Lengths for Ideal Columns

4.4 Critical Stress

5. Torsion

5.1 Introduction

5.2 Torsional Deformation of a Circular Shaft

5.2.1 Shear Strain and Angle of Twist

5.2.2 Torsional Shear Stress

5.2.3 Hooke's Law in Shear. The Torsion Formula

5.2.4 Non Uniform Torsion

5.3 Power Transmission

5.3.1 Torque Diagram

5.4 Statically Indeterminate Torque-Loaded Members

6. Analysis of Combined Stress and Strain

6.1 Introduction: Stresses on Inclined Sections for Axially Loaded Members

6.1.1. Normal and Shear Stresses as a Function of 2q

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6.1.2. Stress Element Representation

6.1.3. Mechanical Failure

6.2 Plane Stress

6.2.1. Stresses on Inclined Sections

6.2.3. Transformation Equations

6.3 Principal and Maximum Shear Stresses

6.4 Mohr's Circle

6.4.1. Mohr's Circle Construction

6.4.2. Stresses on an Inclined Section

6.4.3. Principal Stresses & Maximum Shear Stress

6.5 Hooke's Law for Plane Stress

6.6 Plane Stress

5.4.Course planning and calendar

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weeks	WEEKLY PLANNING SEMESTER	
1ª 2ª	Topic 1	Exercise No. 1 Continuous Assessment

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3ª 4ª 5ª 6ª	Topic 2	Exercise No. 2 Continuous Assessment 1st Practice with Wineva software (Topic 1 and 2) 1st Written Test (Topic 1 and 2)
7ª 8ª 9ª	Topic 3	Exercise No. 3 Continuous Assessment 2nd Practice with software Wineva (Topic 3) 2nd Written Test (Topic 3)

10ª 11ª 12ª	Topic 4	Exercise No. 4 Continuous Assessment 3rd practice with software Wineva (Topic 4) 3rd Written Test (Topic 4)
13ª 14ª	Topic 5	Exercise No. 5 Continuous Assessment 4th Practice with Abaqus

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15ª		software (Topic 5) 4th Written Test (Topic 5)

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The schedule of classes as well as the days of parcial and global exams can be checked on CUD's website (http://cud.unizar.es/calendarios)

Planning of labcourses will be noted to the students in class and/or through the Moodle platform: http://moodle2.unizar.es .

5.5.Bibliography and recommended resources

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Bibliography:

"THE UPDATED BIBLIOGRAPHY OF THE SUBJECT IS CONSULTED THROUGH THE LIBRARY'S WEB PAGE http://psfunizar7.unizar.es/br13/eBuscar.php?tipo=a

BB Calvo Calzada, Begoña. Ejercicios de resistencia de materiales / Begoña Calvo Calzada, Jesús Zurita Gabasa. - 2 ed Zaragoza : Prensas Universitarias de Zaragoza, 2008

BB Martín García, Raúl. Apuntes de elasticidad y resistencia de materiales para ingenieros técnicos / Raúl Martín García, Antonio Illana Martos [Cádiz] : Universidad de Cádiz, Servicio de Publicaciones , D.L. 2003

BB Perez Benedicto, J.A; Remacha Andrés, Mónica; Salesa Bordonaba, Angel.. Resistencia de Materiales. Problemas Resueltos/ J.A.Pérez Benedicto, Mónica Remacha Andres, Angel Salesa Bordonaba.. - 1ª edic Zaragoza: Copycenter, 2011.

BC Argüelles Amado, Antonio. Formulario técnico de elasticidad y resistencia de materiales con problemas resueltos / por Antonio Argüelles Amado, Isabel Viña Olay Madrid : Bellisco, 2004

BC García Cabrera, Juan. Elasticidad y resistencia de materiales : cuestiones y problemas / Juan García Cabrera San Vicente (Alicante) : Club Universitario, D.L. 2006

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Resources:

Material	Format
Topic theory notes Topic problems	Paper/repository
Topic theory notes Topic presentations Topic problems Related links	Digital/Moodle E-Mail
Educational software Wineva.7.0	Web page: wineva.upc.edu/esp/Download.php

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- Gere, James M. "Timoshenko Resistencia de Materiales". Ed. Paraninfo, 2008.
- Ortiz Berrocal, Luis. "Resistencia de Materiales" Ed. McGraw-Hill, 2007.