Course guides
320054 - ECI - Structures and Industrial Construction

Last modified: 29/05/2020

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 737 - RMEE - Department of Strength of Materials and Structural Engineering.

Degree: BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2020 **ECTS Credits:** 9.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Ernest Bernat Masó

Others: Ernest Bernat Masó

PRIOR SKILLS

Knowledge about Strength of materials and elasticity

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. MEC: Knowledge and capabolity for design and calculation of structures and industrial buildings.

TEACHING METHODOLOGY

The subject is organized in the following way:
- Theory sessions, where theoretical concepts will be developed. They will be carried out in class using expositive method. Blackboard and digital presentations will be also used.
- Practical sessions, where theoretical concepts will be applied in order to solve practical examples. They will be carried out in reduced groups in comparison with theory sessions.
- Activities, where different aspects are dealt. They are done individually or in group and at classroom or at home.

LEARNING OBJECTIVES OF THE SUBJECT

The subject has two parts that coincide approximately, depending on the school calendar, with the two two-month courses:

First part: calculation of structures :
- Representing structures by using the common symbols and identifying the boundary conditions and load configurations
- Typing the analytical formulation of the internal efforts distribution (axial, shear and bending) along the structure
- Calculating the movements (displacements and rotations) at any point of a framework using the energetic theorems (Castigliano) and the formulation by Navier-Bresse
- Calculating the reactions at the supports of externally hyperstatic frameworks using the force method and the displacement method

Second part: industrial construction:
- Listing and describing the different steps in the construction process of an industrial building and the job positions that an engineer can develop in this process.
- Designing the structure of an industrial building. Identifying and describing the most common typologies of framed structures and their component elements.
- Sizing and/or checking the stress level of the structural elements of an industrial building (steel structures) accordingly with the current standard. Using the plasticity hypothesis and taking into account the instability processes.
- Analysing and interpreting the documentation which is commonly used for sizing the structural elements (codes, catalogues,')

STUDY LOAD

Type	Hours	Percentage
Hours large group	60,0	26.67
Hours medium group	30,0	13.33
Self study	135,0	60.00

Total learning time: 225 h

CONTENTS

Topic 01: Previous knowledge

Description:
a) Review of elasticity and strength of materials.
b) Review of geometric characteristics of flat sections.
c) Review of calculation of tensions in flat sections.
d) Review of calculation of laws of efforts and movements.

Related activities:
Activity 01.1: Theoretical session about modulus 01
Activity 01.2: Problems resolution about modulus 01

Full-or-part-time: 8h
Theory classes: 2h
Practical classes: 2h
Self study : 4h

Topic 02: Deformed beam.

Description:
a) Equation of elastic.
b) Navier formulas.
c) Theorems of Mohr.

Related activities:
Activity 02.1: Theoretical session about modulus 02
Activity 02.2: Problems resolution about modulus 02

Full-or-part-time: 14h
Theory classes: 4h
Practical classes: 2h
Self study : 8h

Topic 03: Elastic Equations.

Description:
a) Introduction.
b) Formulation.

Related activities:
Activity 03.1: Theoretical session about modulus 03
Activity 03.2: Problems resolution about modulus 03

Full-or-part-time: 10h
Theory classes: 3h
Practical classes: 1h
Self study : 6h

Topic 04: Energy deformation.

Description:
a) Introduction.
b) Clapeyron formula.
c) Rayleigh-Betti theorem.
d) Maxwell's theorem.
e) Energy of deformation.
f) Theorems of Castigliano.
g) Unit force method.

Related activities:
Activity 04.1: Theoretical session about modulus 04
Activity 04.2: Problems resolution about modulus 04

Full-or-part-time: 17h
Theory classes: 5h
Practical classes: 2h
Guided activities: 10h

Topic 05: Compatibility method

Description:
a) Basis of the method.
b) Calculation of one-dimensional hyperstatic structures using the compatibility method.
c) Continuous beams: formula of the three moments.
d) Calculation of two-dimensional hyperstatic structures using the compatibility method.

Related activities:
Activity 05.1: Theoretical session about modulus 05
Activity 05.2: Problems resolution about modulus 05

Full-or-part-time: 19h
Theory classes: 5h
Practical classes: 4h
Self study : 10h

Topic 06: Equilibrium method.

Description:
a) Basis of the method.
b) Calculation of one-dimensional hyperstatic structures using the equilibrium method.
c) Continuous beams: formula of the three turns.
d) Calculation of two-dimensional hyperstatic structures using the equilibrium method.

Related activities:
Activity 06.1: Theoretical session about modulus 06
Activity 06.2: Problems resolution about modulus 06

Full-or-part-time: 19h
Theory classes: 5h
Practical classes: 4h
Self study : 10h

Topic 07: Stiffness method

Description:
A) Basis of the method
B) Case of articulated flat structures.

Related activities:
Activity 07.1: Theoretical session about modulus 07

Full-or-part-time: 12h
Theory classes: 4h
Self study : 8h

Topic 08: Design and execution of an industrial building

Description:
a) Steps of the industrial buildings constructive process.
b) Engineers in construction
c) Standards and construction codes

Related activities:
Activity 08.1: Theoretical session about modulus 08

Full-or-part-time: 6h
Theory classes: 2h
Self study : 4h

Topic 09: Urban planning

Description:
a) Territory organisation
b) Urban codes

Related activities:
Activity 09.1: Theoretical session about modulus 09
Activity 09.2: Problems resolution about modulus 09
Complementary acttivity

Full-or-part-time: 11h
Theory classes: 2h
Practical classes: 1h
Guided activities: 4h
Self study : 4h

Unit 10: Typology of an industrial building.

Description:
a) Vocabulary and terminology.
b) Structural functions.
c) Typologies of frames.
d) Metal profile.

Related activities:
Activity 10.1: Theoretical session about modulus 10
Activity 10.2: Problems resolution of modulus 10
Complementary acttivity

Full-or-part-time: 9h
Theory classes: 2h
Practical classes: 1h
Guided activities: 2h
Self study : 4h

Topic 11: Introduction to metallic structures.

Description:
a) Metal structures: advantages and disadvantages
b) Phases of construction.
c) The material: steel.

Related activities:
Activity 11.1: Theoretical session about modulus 11
Activity 11.2: Problems resolution about modulus 11
Complementary acttivity

Full-or-part-time: 15h
Theory classes: 4h
Practical classes: 1h
Guided activities: 2h
Self study : 8h

Topic 12: Projection and calculation of steel structures.

Description:
a) General.
b) Project bases: execution classes
c) Limit State Design
d) Loads

Related activities:
Activity 12.1: Theoretical session about modulus 12
Activity 12.2: Problems resolution about modulus 12
Complementary acttivity

Full-or-part-time: 17h
Theory classes: 4h
Practical classes: 3h
Guided activities: 2h
Self study : 8h

Topic 13: Serviceability Limit State (SLS)

Description:
a) Bases.
b) Vertical deformation.
c) Horizontal deformations.

Related activities:
Activity 13: Theoretical session about modulus 13
Complementary acttivity

Full-or-part-time: 9h
Theory classes: 2h
Practical classes: 1h
Guided activities: 2h
Self study : 4h

Topic 14: Ultimate Limit State (ULS).

Description:
a) Concept of plastic hinge.
b) Buckling and dent.
c) Classification of sections
d) Strength of sections.

Related activities:
Activity 14.1: Theoretical session about modulus 14
Activity 14.2: Problems resolution about modulus 14
Complementary acttivity

Full-or-part-time: 39h
Theory classes: 10h
Practical classes: 5h
Guided activities: 4h
Self study : 20h

Topic 15: Twisting.

Description:
a) Generalities: balance torsion and compatibility torsion.
b) Type of torsion: uniform, warping and mixed.
c) Strength of sections.

Related activities:
Activity 15.1: Theoretical session about modulus 15
Activity 15.2: Problems resolution about modulus 15

Full-or-part-time: 14h
Theory classes: 4h
Practical classes: 2h
Self study : 8h

Topic 16: Instability of prismatic pieces.

Description:
a) Concept of buckling length.
b) Real parts.
c) Normative treatment.
d) Methodology.

Related activities:
Activity 16.1: Theoretical session about modulus 16
Activity 16.2: Problems resolution about modulus 16

Full-or-part-time: 7h
Theory classes: 2h
Practical classes: 1h
Self study : 4h

GRADING SYSTEM

Students' knowledge acquisition is assessed as follows:
- First examination (N.E.1): 25%
- Second examination (N.E.2): 35%
- Resolution of Problems at classroom (N.P.): 20%
- Lecturer-directed activities (N.A.C.): 20%

- Final qualification (N.F.):

N.F. = 0,25*N.E.1 + 0,35*N.E.2 + 0,20*N.P. + 0,20*N.A.C.

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.
If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

EXAMINATION RULES.

- Depending on the case, lecturer-directed activities will be carried out in a group or individually.
- Lecturer-directed activities developed in class should be carried out in the specified time.
- Lecturer-directed activities developed outside class should be delivered at time specified in the wording.

BIBLIOGRAPHY

Basic:
- Cervera Ruiz, M.; Blanco Díaz, E. Fundamentos de resistencia de materiales y cálculo de estructuras. 2ª ed. Barcelona: Escuela Técnica Superior de Ingenieros de Caminos, Canales y Puertos. Universidad Politécnica de Catalunya, 1995. ISBN 8460092313.
- Cervera Ruiz, M.; Blanco Díaz, E. Mecánica de estructuras [on line]. 2ª ed. Barcelona: Edicions UPC, 2002 [Consultation: 12/05/2020]. Available on: http://hdl.handle.net/2099.3/36196. ISBN 848301517X.
- Arnedo Pena, A. Naves industriales con acero. Madrid: Asociación para la Promoción Técnica del Acero, 2009. ISBN 9788469222744.
- Quintero Moreno, F.; Cudós Samblancat, V. Estructuras metálicas. Vol. 2, La pieza aislada: inestabilidad. 2ª ed. Madrid: la Escuela, 1991. ISBN 8486957095.
- Quintero Moreno, F.; Cudós Samblancat, V. Estructuras metálicas. Vol. 1, La pieza aislada: flexión, torsión. 2ª ed. Madrid: la Escuela, 1991.

Complementary:
- Miquel Canet, Juan. Cálculo de estructuras [on line]. Barcelona: Edicions UPC, 2000 [Consultation: 12/05/2020]. Available on: http://hdl.handle.net/2099.3/36158. ISBN 8483013983.
- Quintero Moreno, F.; Cudós Samblancat, V. Estructuras metálicas: uniones. Madrid: la Escuela, 1988. ISBN 8486957648.
- Argüelles López, R. [et al.]. Estructuras de acero. Vol. 1, Cálculo, norma básica y eurocódigo. Madrid: Bellisco, 1999. ISBN 8493000280.
- Argüelles Álvarez, R. La estructura metálica hoy. 2ª ed. Madrid: Bellisco, 1975-1993. ISBN 8460056724.
- Manual para el cálculo de estructuras metálicas: prontuario ENSIDESA. 7ª ed. Madrid: ENSIDESA, 1990. ISBN 8487405053.

RESOURCES

Other resources:
Profile Celsa is a program that provides access and management of a chart of hot rolled steel profiles supplied by CELSA-Compañía Española de Laminación, S.L.
http://www.celsa.com/Productos.mvc/PerfilesComercial?=Prontuario

The Computer Program of Metallic and Mixed Structures is a freely distributed tool for the analysis, calculation and design of metallic and mixed structures.
https://goo.gl/Fvktuh

The Structural Steel Instruction (EAE) aims to establish the requirements to be met by structural steel structures related to structural safety, fire safety and environmental protection, and to provide a procedure to comply with them, which affects Design, implementation and control of steel structures; All with the ultimate aim, within the framework of the structural reliability laid down in the structural Eurocodes, to ensure adequate safety.
https://goo.gl/cZlu0y

The Basic Document (DB) is designed to establish rules and procedures to meet the basic requirements of structural security.
https://www.codigotecnico.org/images/stories/pdf/seguridadEstructural/DBSE-AE.pdf