Course guide
330525 - EAOCAE - Computer-Aided Engineering (Cae)

Last modified: 04/05/2023

Unit in charge:	Manresa School of Engineering
Teaching unit:	750 - EMIT - Department of Mining, Industrial and ICT Engineering.

Degree:	BACHELOR'S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2017). (Compulsory subject).

Academic year: 2023   **ECTS Credits:** 3.0   **Languages:** Catalan, Spanish, English

LECTURER

Coordinating lecturer:	Riera Colom, Maria Dolores
Others:	Soler Conde, Marc Antoni

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Introduce the use of software (software), commercial or free distribution, in the different activities of Engineering related to the design, development, manufacture and service behavior of products.
2. Use different programs in order to evaluate the behavior in service and in the process of design of components, especially automotive.

Transversal:
3. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.

TEACHING METHODOLOGY

Participatory expository classes. Solving exercises and problems. Numerical simulation. Work in group.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course the student must be able to:
a) Understand the scope of application of CAE tools in the design, development and manufacture of a product.
b) Know the mechanisms of mechanical failure of a component in service.
c) Evaluate the service life of components subjected to the most common mechanical and thermomechanical states.
d) Know the process of selecting the most suitable material for engineering applications.

STUDY LOAD

Type	Hours	Percentage
Self study	45,0	60.00
Hours small group	30,0	40.00

Total learning time: 75 h

CONTENTS

Topic 1: Introduction to CAE

Description:
Presentation of the usual CAE technologies in the field of engineering, with special attention to the automotive sector

Full-or-part-time: 2h
Laboratory classes: 2h

Topic 2: Structural components functionalities and failure mechanism

Description:
Description of the mechanisms of mechanical failure. Numerical calculation exercises with the application of design based on rigidity and resistance.

Full-or-part-time: 8h
Laboratory classes: 6h
Self study : 2h

Topic 3: Structural instability. Buckling failure.

Description:
Presentation of elastic/plastic instability problem by buckling. Numerical exercises with buckling.

Full-or-part-time: 3h
Theory classes: 1h
Laboratory classes: 2h

Topic 4: Monotonic loading fracture failure

Description:
Detailed description of ductile and brittle failure mechanisms. Models to assess the probability of these types of component failures.

Full-or-part-time: 3h
Laboratory classes: 2h
Self study : 1h

Topic 5: Fatigue fracture. Fatigue life

Description:
Study of the fatigue behaviour in structural components. Models to predict the fatigue life.

Related activities:
A.1: Work aimed at predicting the fatigue life of an automotive part.

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

Topic 6: Friction and wear

Description:
Interaction between surfaces: the phenomenon of friction. Wear mechanisms and their prevention

Related activities:
A.2:Work on the analysis of the wear behaviour of automotive components.

Full-or-part-time: 5h
Laboratory classes: 4h
Self study : 1h

Topic 7: Creep

Description:
Mechanical behaviour of materials under stresses at high temperature

Full-or-part-time: 5h
Practical classes: 4h
Self study : 1h

Topic 8: The design process. Property maps. Selection of materials

Description:
The design process of a component with all its phases is exposed. The types of expected failures of the structural parts and how to incorporate them as design limitations are presented. The Ashby property maps and their use in the selection of materials are presented. The method of selection of materials is explained.

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

ACTIVITIES

Activity 1: Fatigue behavior

Description:
Individual or group activity of 2 or 3 students in which the problem of predicting the life of an automotive component subjected to fatigue service is studied.

Specific objectives:
To understand fatigue failure and the prediction of the life of a component under this type of stress, by means of numerical methods and physical models.

Material:
Class notes and explanation, FEM ABAQUS calculation program.

Delivery:
The evaluation of this activity together with the other activities will be part of the evaluation as specified in the corresponding section of the teaching guide.

Full-or-part-time: 10h
Self study: 10h

Activity 2: Friction and wear

Description:
Individual or group activity of 2 or 3 students in which the problem of predicting the change in geometry due to wear of an automotive component subjected to friction is posed.

Specific objectives:
Learn how to predict the wear life of automotive components by combining a physical model and a numerical model.

Material:
Class notes and explanation, FEM ABAQUS calculation programme.

Delivery:
The evaluation of this activity together with the other activities will be part of the evaluation as specified in the corresponding section of the teaching guide.

Full-or-part-time: 10h
Self study: 10h

Activity 3: Materials selection

Description:
Individual or group activity of 2 or 3 students in which the problem of predicting the change of geometry due to wear of an automotive component subjected to friction is studied.

Specific objectives:
To understand the proposed material selection method and the use of the CES-Edupack software.

Material:
Class notes and explanation, FEM ABAQUS calculation program.

Delivery:
A deliverable-report will be prepared with the resolution of the proposed exercise. The assessment of this activity together with the other activities will form part of the assessment as specified in the corresponding section of the teaching guide.

Full-or-part-time: 5h
Self study: 5h

Activity 4: Exam

Description:
Written test in which the student must show the degree of achievement of the knowledge acquired on the topics explained. It will include a FEM numerical calculation.

Specific objectives:
Consolidate and demonstrate the knowledge acquired so far.

Delivery:
Written exam. The assessment of this together with that of the other activities will form part of the assessment as specified in the corresponding section of the teaching guide.

Full-or-part-time: 12h
Laboratory classes: 2h
Self study: 10h

GRADING SYSTEM

The grade will be calculated according to the formula:
NFINAL = (NTEORIA * 0.50) + (NACTIVITIES * 0.50)
Where NTEORIA is the mark for written exam that constitutes the activity A4.
NACTIVITIES is the one corresponding to the part of the works proposed in the activities A1, A2 and A3.
NACTIVITIES = 0.4 * A1 + 0.4 * A2 + 0.2 * A3

EXAMINATION RULES.

Activities A1, A2 and A3 must be developed in groups of 1, 2 or 3 students. The written exam, A4, will be individual. All reports submitted must be in ISO 9000 format. The reports will be original. Copying the contents of these is a reason to suspend the activity.

BIBLIOGRAPHY

Basic:
- Ashby, M. F; Jones, David R. H. Materiales para ingeniería, Vol. 2 [on line]. Barcelona [etc.]: Reverté, 2008-2009 [Consultation: 14/06/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=7725. ISBN 9788429172560.
- Ashby, M. F; Jones, David R. H. Materiales para ingeniería, Vol. 1 [on line]. Barcelona [etc.]: Reverté, 2008-2009 [Consultation: 27/05/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?docID=5635457. ISBN 9788429172553.
- Ashby, M. F. Materials selection in mechanical design [on line]. 4th ed. Burlington, MA: Butterworth-Heinemann, 2011 [Consultation: 10/06/2022]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/9781856176637/materials-selection-in-mechanical-design. ISBN 9781856176637.

Complementary:
- Dieter, George Ellwood; Bacon, David. Mechanical metallurgy. SI metric ed. / adapted by David Bacon. London [etc.]: McGraw-Hill Book Company, cop. 1988. ISBN 007084187X.
- Hosford, William F; Caddell, Robert M. Metal forming : mechanics and metallurgy. 4th ed. Cambridge: Cambridge University, 2011. ISBN 9781107004528.
- Alcalá, J; Llanes, L. M; Mateo García, Antonio Manuel; Salán, M. N; Anglada, Marc. Fractura de materiales [on line]. Barcelona: Edicions UPC, 2002 [Consultation: 12/11/2020]. Available on: http://hdl.handle.net/2099.3/36175. ISBN 8483015927.

RESOURCES

Other resources:
- Commercial finite element calculation software ABAQUS (ABAQUS a-v18); ANSYS (ANSYS Academia-STUDENT 2019 R2) and CES-Edupack.