Course guide
330522 - TPTM - Process Technologies and Materials Transformation

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:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Riera Colom, Maria Dolores

Others: Soler Conde, Marc Antoni

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE13. Knowledge and application of production and manufacturing systems.

Generical:
CG3. Knowledge of basic and technological subjects that will enable students to learn new methods and theories and that will endow them with the versatility needed to adapt to new situations.
CG4. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and skills in the field of automotive engineering.

Transversal:
1. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.
2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
4. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.

Basic:
CB3. That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.
CB5. Students have developed those learning skills necessary to undertake further studies with a high degree of autonomy.

TEACHING METHODOLOGY

MD1 Master class or lecture (EXP)
MD2 Problem solving and case study (RP)
MD3 Practical work in laboratory or workshop (TP)
MD5 Small-scale project, activity or assignment (PR)
MD7 Assessment activities (EV)

LEARNING OBJECTIVES OF THE SUBJECT

The main goal is to know different technologies used to manufacture parts with engineering materials and to be able to select the most appropriate method depending on the geometry and properties of the component that will be obtained, as well as the nature of the material to process, always taking into account the economic aspect of the operation.

STUDY LOAD

Type	Hours	Percentage
Hours small group	30,0	20.00
Self study	90,0	60.00
Hours large group	30,0	20.00

Total learning time: 150 h

CONTENTS

Topic 1: Introduction to transformation processes of materials for engineering

Description:
Classification of the types of processes used for manufacturing workpieces.

Specific objectives:
Acquire an overview of different manufacturing processes for engineering applications.

Related activities:
Analysis of a mechanical component using FEM numerical simulation (Activity 1).

Full-or-part-time: 10h
Theory classes: 2h
Laboratory classes: 4h
Self study : 4h

Topic 2: Modelling and simulation of forming processes

Description:
Introduction to modelling and simulation of materials and processes.
Mechanics of materials.
Plasticity theory.

Specific objectives:
Define the concepts of modeling and numerical simulation in the field of forming and current tools for process design.
Understand the state of stresses and strains of a solid.
Learn the stress-strain relationships in plastic regime of different engineering materials.

Related activities:
Modelling and simulation of plastic deformation (Activity 2).

Full-or-part-time: 14h
Theory classes: 4h
Laboratory classes: 6h
Self study : 4h

Topic 3: Forming processes of metallic materials

Description:
Detailed description of the most important techniques to manufacture metallic parts: molding, forming by plastic deformation and powder metallurgy.

Specific objectives:
Know the fundamental forming technologies of metallic materials.

Related activities:
Design and optimization of a hot forging process (Activity 3).
Progress evaluation test I (Activity 8).

Full-or-part-time: 48h
Theory classes: 8h
Laboratory classes: 10h
Self study : 30h

Topic 4: Forming of polymeric materials

Description:
Forming of thermosetting and thermoplastic polymers.
Manufacture of elastomeric components.

Specific objectives:
Learn the basic methods of manufacturing the different types of polymers: thermoplastics, thermosets and elastomers.

Related activities:

Modelling and simulation of the mechanical behavior of elastomers (Activity 4).

Full-or-part-time: 18h
Theory classes: 4h
Laboratory classes: 4h
Self study : 10h

Topic 5: Forming processes of ceramics and glass

Description:
Forming of traditional and technical ceramics.
Forming techniques of glass.

Specific objectives:
Know the techniques commonly used to manufacture pieces of ceramic and glass materials.

Related activities:

Small group work, with a written report and a presentation, on an outstanding manufacturing process of ceramic and/or glass pieces (Activity 5).

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

Topic 6: Forming techniques of composite materials

Description:
Detailed description of the most important techniques for manufacturing parts of different types of composite materials, especially polymer matrix composites

Specific objectives:
Know the fundamental forming technologies of composite materials

Related activities:
Small group work, with a written report and a presentation, on an outstanding manufacturing process of composites pieces (Activity 6).

Full-or-part-time: 14h
Theory classes: 4h
Self study : 10h

Topic 7: Bonding technologies

Description:

Metal welding.
Adhesive bonded
Dissimilar joints.

Specific objectives:
Learn the different types of metal welding and be able to select the most appropriate in each case.
Adhesives used for bonding materials.
Analysis of the joints between materials of different structure or different nature.

Related activities:
Defect analysis in welded joints (Activity 7).
Progress evaluation test II (Activity 9).

Full-or-part-time: 34h
Theory classes: 6h
Laboratory classes: 6h
Self study : 22h

ACTIVITIES

Activity 1: Analysis of a mechanical component using FEM numerical simulation

Description:
Analysis of the elastic deformation behavior of a metal component.

Specific objectives:
Introduction to the use of a commercial programme for structural calculation and thermo-mechanical coupling using the finite element method (FEM).

Material:
ABAQUS calculation programme, class notes, recommended bibliography.

Delivery:
A report will be prepared with the resolution of a simulation problem for individual practice of the technique.
The evaluation of this activity is specified in the corresponding section of the teaching guide.

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

Activity 2: Modelling and simulation of plastic deformation

Description:
Analysis of the plastic deformation behavior of a metal component.

Specific objectives:
To implement the modelling of plastic deformation behaviour in the analysis of the mechanical state of metallic components.

Material:
ABAQUS calculation programme, class notes, recommended bibliography.

Delivery:
A report will be prepared with the resolution of a simulation problem for individual practice of the technique.
The evaluation of this activity is specified in the corresponding section of the teaching guide.

Full-or-part-time: 10h
Laboratory classes: 6h
Self study: 4h

Activity 3: FEM numerical calculation exercise of a forming process that uses the plastic deformation of metals

Description:
FEM numerical simulation to determine the behavior of a workpiece during its shaping.

Specific objectives:
Optimisation of forming processes by means of numerical simulation.
Practice with the numerical calculation programme FEM.

Material:
ABAQUS calculation programme, class notes, recommended bibliography.

Delivery:
A report will be prepared with the resolution of a simulation problem for individual practice of the technique.
The evaluation of this activity is specified in the corresponding section of the teaching guide.

Full-or-part-time: 20h
Laboratory classes: 10h
Self study: 10h

Activity 4: Modelling and simulation of the mechanical behavior of elastomers

Description:
FEM numerical simulation to determine the behavior of an elastomeric piece when working.

Specific objectives:
To learn how to design highly non-linear material components.
Practice with the numerical calculation programme FEM.

Material:
ABAQUS calculation programme, class notes, recommended bibliography.

Delivery:
A report will be prepared with the resolution of a simulation problem for individual practice of the technique.
The evaluation of this activity is specified in the corresponding section of the teaching guide.

Full-or-part-time: 14h
Laboratory classes: 4h
Self study: 10h

Activity 5: Small group work on forming ceramic materials

Description:
Project about forming of ceramic and glass materials developed in small groups, to be presented in a report and orally.

Specific objectives:
Working in groups.
Make reliable use of available information.
Learn to prepare technical reports and oral presentations.

Material:
Recommended bibliography and research in specific databases.

Delivery:
Written report and oral presentation.
The assessment of this activity is specified in the corresponding section of the teaching guide.

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

Activity 6: Small group work on forming composite materials

Description:
Project about forming composite materials developed in small groups, to be presented in a report and orally.

Specific objectives:
Working in groups.
Make reliable use of available information.
Learn to prepare technical reports and oral presentations.

Material:
Recommended bibliography and research in specific databases.

Delivery:
Written report and oral presentation.
The assessment of this activity is specified in the corresponding section of the teaching guide.

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

Activity 7: Defect analysis in welded joints

Description:
Laboratory practice for the study of macrographs and micrographs of metal fusion welding seams. Observation of defects

Specific objectives:
Experimentally practise the knowledge acquired on defectology in welded joints.

Material:
Laboratory for the preparation and microscopic and loupe observations of metallographic specimens with fusion joints.

Delivery:
A written report will be prepared with the results of the practice. The evaluation of this activity is specified in the corresponding section of the teaching guide.

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

Activity 8: Evaluation test I

Description:
Written test in which the student must show the degree of achievement of the knowledge acquired on the topics explained.

Specific objectives:
Consolidate and demonstrate the knowledge acquired.

Material:
Calculator.

Delivery:
The assessment of this activity is specified in the corresponding section of the teaching guide.

Full-or-part-time: 22h
Theory classes: 2h
Self study: 20h

Activity 9: Evaluation test II

Description:
Written test in which the student must show the degree of achievement of the knowledge acquired on the topics explained.

Specific objectives:
Consolidate and demonstrate the knowledge acquired.

Material:
Calculator.

Delivery:
The assessment of this activity is specified in the corresponding section of the teaching guide.

Full-or-part-time: 22h
Theory classes: 2h
Self study: 20h

GRADING SYSTEM

Activity 1: 3%
Activity 2: 3%
Activity 3: 3%
Activity 4: 3%
Activity 5: 10%
Activity 6: 10%
Activity 7: 3%
Activity 8: 30%
Activity 9: 30%
Class attendance and participation: 5%

EXAMINATION RULES.

these activities are individual, except for those in which it is clearly specified that they are in groups. In order to carry out the laboratory practices, it is necessary to have passed the previous questionnaire that will be published in advance on the digital campus. 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:
- Black, J. T.; Kohser, R. A. DeGarmo's materials and proceses in manufacturing. 11th ed. Hoboken: Wiley, 2013. ISBN 9780470873755.
- Dieter, G. E.; Bacon, D. Mechanical metallurgy. SI metric ed. London: McGraw-Hill Book Company, 1988. ISBN 9780071004060.
- Hosford, W. F.; Caddell, R. M. Metal forming: mechanics and metallurgy. 4th ed. Cambridge: Cambridge University, 2011. ISBN 9781107004528.

Complementary:
- Ashby, M. F.; Jones, D. R. H. Materiales para ingeniería. Vol. 1, Introducción a las propiedades, las aplicaciones y el diseño [on line]. Barcelona: 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.; Jones, D. R. H. Materiales para ingeniería. Vol. 2, Introducción a la microestructura, el procesamiento y el diseño [on line]. Barcelona: 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.
- ASM International. Ceramics and glasses. Ohio: ASM International, 1991. ISBN 0871702827.
- Kobayashi, S.; Oh, Soo-Ik; Altan, T. Metal forming and the finite-element method. New York: Oxford University Press, 1989. ISBN 0195044029.
- Woishnis, W., ed. Engineering plastics and composites. 2nd ed. Materials Park, Ohio: ASM International, 1993. ISBN 087170483 .
- Gilbert, Marianne. Brydson's plastics materials [on line]. 8th ed. Amsterdam: Butterworth-Heinemann, 2017 [Consultation: 10/06/2022]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/9780323358248/brydsons-plastics-materials. ISBN 9780323358248.
- Mangonon, P. L. Ciencia de materiales: selección y diseño. México: Prentice Hall, 2001. ISBN 9702600278.

RESOURCES

Other resources:
-Commercial calculation software using the finite element method ABAQUS.
-Laboratory equipment.