240AU021 - Structural Analysis

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 737 - RMEE - Department of Strength of Materials and Structural Engineering
Academic year: 2019
Degree: MASTER’S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2012). (Teaching unit Compulsory)
ECTS credits: 4,5
Teaching languages: Spanish

Teaching staff

Coordinator: JAVIER AYNETO GUBERT
Others: - MIQUEL FERRER BALLESTER

Opening hours

Timetable: Xavier Ayneto Gubert
Mondays from 8h to 11h and Fridays from 14:30h to 15h.

Miquel Ferrer Ballester
Mondays/Wednesdays/Thursdays/Fridays from 11:30 to 13:00h.

Prior skills

Knowledge of Continuous Mechanics and Endurance of Materials

Degree competences to which the subject contributes

Specific:
1. Apply knowledge of mathematics, physics and technology obtained through study, experience and practice, using critical reasoning to establish economically viable solutions to technical problems in the automotive sector
5. Develop ability to solve problems that are unfamiliar, incompletely defined, considering the possible methods of solution, including the most innovative, selecting the most appropriate, and correcting implementation, evaluating different design solutions.

Transversal:
3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.
4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

Teaching methodology

a) 42h face-to-face sessions, consisting of lectures and practical sessions to solve problems.
b) Autonomous learning based on the resolution of short problems, at home.
c) Cooperative learning based on carrying out a project or resolution of a case, in teams of three students.

Learning objectives of the subject

Learn the basics of the structure mechanics, specifying the phenomenon and the types of structures and most
characteristic components in the automotive field, so as to conceive and/or optimize the design.
- Static and lineal performance
- Plasticity and non linearity materials
- Non lineal geometrical performance: bending and local buckling
- Lineal and non lineal structural dynamics: modal harmonic response, transient, crash
- Fatigue of components, systems and structures
- Experimental methods of structural analysis
- Combined use of simulation and experimentation

Learn the techniques and methods of structural analysis, specially the Finite Element Method (FEM).

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Hours large group: 27h</th>
<th>24.00%</th>
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</thead>
<tbody>
<tr>
<td>Hours medium group: 0h</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>Hours small group: 13h 30m</td>
<td>12.00%</td>
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<tr>
<td>Guided activities: 0h</td>
<td>0.00%</td>
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<tr>
<td>Self study: 72h</td>
<td>64.00%</td>
<td></td>
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</tbody>
</table>
### Content

| 1. Structural analysis in automotive engineering | Learning time: 13h 30m  
Theory classes: 4h 30m  
Self study : 9h |
|---|---|
| **Description:**  
Qualitative presentation of the role of the structural analysis in the design and development of a new vehicle. |  |
| **Related activities:**  
Additional information research |  |
| **Specific objectives:**  
Describe the different applications of the structural analysis regarding to the calculation, simulation and assay of a car's bodywork, systems and components. |  |

| 2. Review of basic concepts in the structural analysis | Learning time: 13h 30m  
Theory classes: 4h 30m  
Self study : 9h |
|---|---|
| **Description:**  
Review of the basic concepts of the mechanics of the continuous means and the endurance of the materials applicable to the structural analysis in the automotive field. |  |
| **Related activities:**  
Resolution of application exercises. |  |
| **Specific objectives:**  
Establish a solid base on the physical concepts in which the structural analysis in the automotive field supports. |  |

| 3. Introduction and basics of the finite element method | Learning time: 26h 30m  
Theory classes: 4h 30m  
Practical classes: 1h 30m  
Self study : 20h 30m |
|---|---|
| **Description:**  
Introduction to the finite element method as a technological base for the simulation of the structural performance. |  |
| **Related activities:**  
Application exercises. Research of information on the finite element formulations. Simulation exercise with the FEM. |  |
| **Specific objectives:**  
Understand the continuous structural systems as an extension of the discrete systems. Present the interpolation concepts, discretisation and the general approach of the method for linear elastic problems. |  |
## 4. Technological and practical facts for the application of the method

**Description:**
Complete the general theory vision on the finite element method (FEM) with the application details which the structural analysis engineers will find when doing their job.

**Related activities:**
Application exercises. Simulation practice with the FEM

**Specific objectives:**
Details related to the numerical techniques used, with the definition of numerical models, with the solution process and with the interpretation of the results.

**Learning time:** 19h 30m
- Theory classes: 4h 30m
- Practical classes: 1h 30m
- Self study: 13h 30m

## 5. Non linear structural analysis

**Description:**
Description and importance of the non linear performance of the structures (non geometrical linearity) and the materials (non material linearity) in components and the elements of a car's bodywork. Analytical and computer methods of analysis.

**Related activities:**
Simulation exercises with finite elements.

**Specific objectives:**
Analyse the non linear geometrical and plastic response of the structural systems by the analytic and computer methods.

**Learning time:** 18h
- Theory classes: 3h
- Practical classes: 1h 30m
- Self study: 13h 30m
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## 6. Lineal elastic structural dynamics

**Learning time:** 12h  
Theory classes: 4h 30m  
Practical classes: 1h 30m  
Self study: 6h

**Description:**
Ways and own frequences of free vibration of structures and components. Structural cushioning. Analysis of harmonic response. Modal superposition. Application of the FEM.

**Related activities:**
Application exercises. Simulation practise with Finite Elements.

**Specific objectives:**
- Analyse the ways and own frequencies of vibration of a structure or component. Establish the necessary modifications in the structure or component to modify its dynamic performance.
- Design structural elements and components for finite or infinite life. Suitably use the models and calculation tools.

## 7. Non lineal structural dynamics. Crash

**Learning time:** 9h  
Theory classes: 4h 30m  
Self study: 4h 30m

**Description:**
Implicit and explicit direct integration by the FEM.

**Related activities:**
Application exercises. Simulation practise with Finite Elements.

**Specific objectives:**
- Analyse the transient dynamic phenomenon with no linearities (geometrical and material), as for example shocks, by an implicit and explicit direct integration.
8. Fatigue and durability

Learning time: 3h
- Theory classes: 1h 30m
- Self study: 1h 30m

**Description:**

**Related activities:**
Application exercises.

**Specific objectives:**
Design structural elements and components with finite life. Complete finite life predictions. Appropriate use for the models of the analytical and numerical calculations.

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(ENG) 1. Anàlisi estructural a l'enginyeria d'automoció

**Degree competences to which the content contributes:**

(ENG) 2. Resum dels conceptes bàsics a l'anàlisis estructural

**Degree competences to which the content contributes:**

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**Qualification system**

Final Mark = 0.5 * MFE + 0.5 * CAM
MFE: Mark of the final exam
CAM: Continuous assessment marks (reports of lab practices + deliverables exercises)

Si la asignatura queda suspendida con una calificación igual o superior a 3, se podrá realizar un examen oral de reavaluación. En este caso, la nota del examen de revaluación (NER) sustituye a la nota del examen final (NEF) en el cálculo de la nota final: Nota Final = 0,5 * NER + 0,5 * NEC

**Regulations for carrying out activities**

a) Final exam: A4 formula sheet carried out by the student and a no programmable calculator.
b) Continuous evaluation: different delivery exercises to be solved individually at home will be set and simulation by finite elements practices will be performed in teams of three people.
c) Course project: a case or project will have to be solved in teams of three people as homework. A report of the project will have to be written and will have to be orally presented and the students will have to answer to the questions of the professors.
d) Examen de Revaluación: el alumno tendrá que defender oralmente uno de los temas del curso que se le asignará por sorteo en el mismo momento de la pueba.
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Bibliography

Basic:


Others resources:

Notes and slides from the subject. Xavier Ayneto, 2014