Course guide
820430 - DIMA - Machine Design

Last modified: 20/02/2025

Unit in charge:	Barcelona East School of Engineering
Teaching unit:	712 - EM - Department of Mechanical Engineering.

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

Academic year: 2024   **ECTS Credits:** 6.0   **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer:	PEDRO ORTIZ MORÓN
Others:	Primer quadrimestre: PEDRO ORTIZ MORÓN - Grup: M11, Grup: M12, Grup: M13, Grup: M14, Grup: T11, Grup: T12, Grup: T13 DOMINGO SANTOS ESPADA - Grup: T11, Grup: T12, Grup: T13

REQUIREMENTS

CINEMÀTICA I DINÀMICA DE MÀQUINES - Precorequisit
RESISTÈNCIA DE MATERIALS - Prerequisit

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEMEC-20. Calculate the characteristics of, design and test machines.

Transversal:
04 COE N3. 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

The subject uses the expository methodology and study by case, with a presentation of each theoretical topic accompanied by comments that encourage adequate and comprehensive understanding of the concepts. On the other hand, problems representative of the contents in the classroom will be solved and students will be made available the problems, solved problems and diverse material for autonomous study.

LEARNING OBJECTIVES OF THE SUBJECT

1, Learn the basics of machine design. 2. To enable the student to develop design algorithms that allow the calculation and design of machine components. 3. Develop skills in experimental techniques and results analysis. 4. Develop an awareness of design safety and the importance of the use of standards and codes. 5. Familiarity with the use of advanced computational techniques in solving computational problems of mechanical elements. 6. Develop modeling capabilities. 7. Promote independent learning through observation by the student of mechanical systems that surround it, and his mental abstraction useful models for the mechanical calculation. 8. Promote critical thinking and intuitive interpretation of the results obtained through calculations. 9.Purchase orders of magnitude of common physical properties.

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours large group	45,0	30.00
Hours small group	15,0	10.00

Total learning time: 150 h

CONTENTS

1 - INTRODUCTION TO THE DESIGN OF MACHINES

Description:
1.1 Design in mechanical engineering.
1.2 Relation of the subjects of the degree in relation to Machine Design.
1.3 Design considerations.
1.4 Materials in the mechanical design.

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

2 - CONSTANT LOAD. STATIC

Description:
2.1 Analysis of solicitations. Free-Body diagrams. Reactions
2.2 Simple efforts in machine elements: shear stress, tensile / compressive stress, bending and torsion moments.
2.3 Resistant design. Static safety factor.
2.4 Main tensions. Mohr's Circle for plane stress.
2.5 Static failure theories. Equivalent Von Mises - Hencky Stress.

Full-or-part-time: 15h
Theory classes: 6h
Laboratory classes: 3h
Self study : 6h

3 – BRITTLE / DUCTILE

Description:
3.1 Brittle material - ductile material.
3.2 Brittle fracture - ductile fracture.

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

4 - STRESS CONCENTRATION

Description:
4.1 Description of the stress concentration phenomenon.
4.2 Tables of stress concentration factors.
4.3 Effect on resistant elements depending on the static or variable character of the load and the brittle / ductile behaviour of the material.

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

5 - VARIABLE LOADS. FATIGUE

Description:
5.1 Fatigue of the materials. Introduction to the phenomenon and mechanism of fatigue failure.
5.2 Recent accidents caused by fatigue.
5.3 Expression of a variable load cycle in medium component and amplitude component.
5.4 Rotating bending test. Wöhler diagram for the specimen.
5.5 Materials with endurance limit and materials with fatigue strenght.
5.6 Correction of the Wöhler diagram: endurance limit modifying factors.
5.7 Influence of the mean stresses in uniaxial fatigue.
5.8 Söderberg diagram. Description, equations and use in the resolution of cases of uniaxial fatigue with medium tensions.
5.9 Security factor to infinite life. Safety factor to life N cycles.

Full-or-part-time: 24h
Theory classes: 7h
Laboratory classes: 3h
Self study : 14h

6 - DESIGN OF ELEMENTS OF MACHINES SUBMITTED TO VARIABLE LOADS

Description:
Application of the tools exposed in the previous topics in different cases of resistant elements submitted to variable loads. These cases have been selected seeking to show different typologies, both in the type of machine element solved, and in the variability of the loads applied.

Full-or-part-time: 29h
Theory classes: 6h
Self study : 23h

7 - MECHANICAL TRANSMISSIONS

Description:
7.1 Definition.
7.2 Principles of operation.
7.3 Comparative characteristics according to the operating principle.
7.4 Functions of mechanical transmissions.
7.5 Some useful classifications in transmissions.
7.6 Descriptive exposition of mechanical transmission elements.
7.7 Transmission ratio.

Full-or-part-time: 11h
Theory classes: 3h
Laboratory classes: 3h
Self study : 5h

8 - FORCES IN MECHANICAL TRANSMISSIONS THROUGH GEARS

Description:
8.1 Spur Gears.
8.1.1 General.
8.1.2 Geometric parameters in spur gears.
8.1.3 Forces in transmissions with spur gears.
8.2 Helical gears.
8.2.1 General.
8.2.2 Geometrical parameters in helical gear.
8.2.3 Forces in transmissions with helical gears.
8.2.4 Compensation of the axial component.
8.2.5 Effect of the axial component on the diagram of bending moments.

Full-or-part-time: 16h
Theory classes: 5h
Laboratory classes: 3h
Self study : 8h

9 - FORCES IN MECHANICAL TRANSMISSIONS THROUGH BELTS AND CHAINS

Description:
9.1 Flat and trapezoidal belts.
9.2 General.
9.3 Geometric parameters in belt and chain transmissions.
9.4 Forces in transmissions with flat and trapezoidal belts.
9.4 Expression of Eytelwein, stress ratio, pretension.
9.5 Forces in transmissions with toothed belts and chains.

Full-or-part-time: 11h
Theory classes: 3h
Laboratory classes: 3h
Self study : 5h

10 - DESIGN OF SHAFTS

Description:
10.1 Introduction. Definition of axel, shaft and spindle. Most used types, shapes and materials.
10.2 Resistant shaft design.
10.3 Deformations in axels and shafts.
10.4 Critical speed.
10.5 Design recommendations.
10.6 Hub - shaft bushing.
10.7 Joints for tree coupling.

Full-or-part-time: 34h
Theory classes: 10h
Self study : 24h

GRADING SYSTEM

The qualification consists of the marks obtained in three evaluation acts: partial exam (EP), practice test (PR) and final exam (EF), with an initial weighting of 45%, 10% and 45% respectively.

In application of the concept of continuous evaluation, and taking into account the fact that the concepts demanded in the partial exam continue to be asked in the final exam, a second weighting is proposed that favors the students who have obtained a worse result in the first test, being this second weighting 25%, 10% and 65% respectively.

Thus the final grade of the subject is determined by the expression:

DIMA NF = MAX [(0.45NEP + 0.10NPR + 0.45NEF); (0.25NEP + 0.10NPR + 0.65NEF)]

This subject does not have the re-evaluation test planned.

EXAMINATION RULES.

Practice Test:
24 questions with four answers.
Only one of the answers is correct. Questions answered incorrectly subtract 1/3 and those not answered do not subtract.
You must answer in the box at the top of the first page and preferably using capital letters.
You cannot have any documentation or calculator.

Partial and Final Exams.
You cannot use graphing calculators or those that can store or transmit information, view pdf files or any other type.
It is essential that all the calculations made appear in detail in the exam solution.
Calculator Solver solving is not supported as an answer to an equation.
Mobile phones must be disconnected and stored out of the student's reach during the exam.
No questions will be answered: understanding the statement is part of the test.
You cannot take the exam in pencil or use a red pen.
Answer sheets should be used on both sides and in the natural order.
The documentation that must be taken for examination is the printout of the document Tablas imprimir examen DIMA available at Atenea.
You can take an A4 sheet form on both sides.

BIBLIOGRAPHY

Basic:

- Budynas, Richard G; Nisbett, J. Keith; Shigley, Joseph Edward. Diseño en ingeniería mecánica de Shigley. 10ª ed. México [etc.]: McGraw-Hill, 2019. ISBN 9781456267568.
- Avilés, Rafael. Métodos de cálculo de fatiga para ingeniería. Madrid: Paraninfo, cop. 2015. ISBN 9788428335188.
- Pedrero Moya, José Ignacio. Fundamentos de diseño de máquinas. Madrid: Universidad Nacional de Educación a Distancia, cop. 2000. ISBN 8436241255.
- Norton, Robert L; Enríquez Brito, Antonio; Saldaña Sánchez, Sergio; Hernández Fernández, Ángel; Acevedo Alvarado, Mario. Diseño de máquinas : un enfoque integrado. 4a ed. México [etc.]: Prentice-Hall, cop. 2011. ISBN 9786073205894.
- Juvinall, Robert C; Marshek, Kurt M. Fundamentals of machine component design. 5ª ed. Hoboken: John Wiley & Sons, 2012. ISBN 9781118012895.

Complementary:

- Gere, James M; Timoshenko, Stephen; Bugeda, G. Resistencia de materiales. 5ª ed. España [etc.]: International Thomson Editores, cop. 2002. ISBN 9788497320658.
- Calero Pérez, Roque; Carta Gonzalez, José Antonio. Fundamentos de mecanismos y máquinas para ingenieros. Madrid [etc.]: McGraw-Hill, 1999. ISBN 844812099X.
- Besa Gonzálvez, Antonio José. Componentes de máquinas : fatiga de alto ciclo : problemas y ejercicios resueltos [on line]. Madrid [etc.]: Pearson, cop. 2003 [Consultation: 29/04/2020]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=3060. ISBN 9788483229187.
- Chevalier, A. Dibujo industrial. México [etc.]: Limusa, 1992. ISBN 968183948x.
- Juvinall, Robert C; Marshek, Kurt M. Diseño de elementos de máquinas. 2a edición en español. México, D.F.: Limusa, cop. 2013. ISBN 9786070504365.
- Faires, Virgil Moring. Diseño de elementos de máquinas. México, D.F.: Limusa, cop. 1994. ISBN 9681842073.
- Spotts, M. F; Shoup, T. E; León Cárdenas, Javier; Cera Alonso, José María de la. Elementos de máquinas. México [etc.]: Pearson Educación, cop. 1999. ISBN 9701702522.