Course guide
220262 - 220262 - Machine Design and Mechanical Vibrations

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 712 - EM - Department of Mechanical Engineering.

Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2013). (Optional subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: Clot Razquin, Arnau
Arcos Villamarín, Robert

Others: Orta Roca, Jordi

PRIOR SKILLS

It is highly recommended that the interested studend has a good mathematical background and previous knowledge of the key concepts in statics, kinematics and dynamics.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
5. Ability to learn and understand the dynamic phenomena and its formulation for application in the development of each of the stages of conception, design and mechanical calculations.

TEACHING METHODOLOGY

The teaching method is divided into the following four types of activities:
- Theoretical lectures: Introduction of the theoretical basis of the subject (concepts, methods and results), using examples to ease its comprehension.
- Problem-solving lectures: Solving proposed problems by using the newly acquired theoretical concepts. The aim of the proposed problems will be to habituate the student to use basic problem-solving tools.
- Laboratory demonstrations: Experimental demostrations to show some of the theoretical concepts of the subject.
- Autonomous work: Self-directed study of the course notes and problems presented by the lecturers in order to gain a deep understanding of the subject's key concepts.

LEARNING OBJECTIVES OF THE SUBJECT

Understanding of the mechanical design of machine components. Capability of chosing a machine component by considering its type, its properties and its role. Knowledge of the calculation procedures used for designing machine components, taking into account the most important failure criterias and the applied dynamic loads.
Understanding of the vibrations of a mechanical system. Understanding of the mathematical and experimental methods used to study the vibration of a system with one or several degrees of freedom. Theoretical and experimental understanding of the vibration isolation.

STUDY LOAD

Type	Hours	Percentage
Self study	80,0	64.00
Hours small group	15,0	12.00
Hours large group	30,0	24.00

Total learning time: 125 h

CONTENTS

Module 1: Introduction to the mechanical design of machines and to the mechanical vibrations.

Description:
Introduction to the significance of the dynamic factors in mechanical design. Introduction to the significance of mechanical vibrations.

Related activities:
Theoretical lectures and self-guided learning.

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

Module 2: Machine component design

Description:
Design, selection and characterisation of transmission and suspension components. Practical application of the acquired knowledge.

Related activities:
- Theoretical lectures.
- Self-guided learning.
- Laboratory demonstration 1.
- Mid-course exam.
- End-course exam.

Full-or-part-time: 60h 30m
Theory classes: 14h
Laboratory classes: 7h 30m
Self study : 39h

Module 3: Mechanical vibrations

Description:
Introduction to the vibration of systems with a single degree of freedom: Natural frequency, damping, free and forced response, frequency response functions.
Introduction to the vibration of systems with several degrees of freedom: Natural modes of vibration, free and force response of the system.
Experimental study of a passive vibration isolation system.

Related activities:
- Theoretical lectures.
- Self-guided learning.
- Laboratory demonstration 2.
- Laboratory demonstration 3.
- Laboratory demonstration 4.
- Mid-course exam.
- End-course exam.

Full-or-part-time: 60h 30m
Theory classes: 14h
Laboratory classes: 7h 30m
Self study : 39h

ACTIVITIES

Theoretical lectures

Description:
Subject theoretical lectures.

Specific objectives:
Understanding the main dynamic phenomenas associated to the design of machines and their importance in the design and calculation of machine components.
Understanding the vibration response of a mechanical system. Knowledge of the mathematical methods that allow to predict and analyse this response.

Full-or-part-time: 44h
Theory classes: 26h
Self study: 18h

Laboratory demonstration 1

Description:
Laboratory demonstration about the design and calculation of mechanical components.

Delivery:
Report of laboratory demonstration 1.

Full-or-part-time: 12h 30m
Laboratory classes: 3h 30m
Self study: 9h

Laboratory demonstration 2

Description:
MATLAB introduction.

Delivery:
Report of the laboratory demonstration 2.

Full-or-part-time: 12h 30m
Laboratory classes: 3h 30m
Self study: 9h

Laboratory demonstration 3

Description:
Measurement and processing of vibration signals.

Specific objectives:
To know the experimental procedures used for measuring mechanical vibrations.

Delivery:
Report laboratory demonstration 3

Full-or-part-time: 12h 30m
Laboratory classes: 3h 30m
Self study: 9h

Laboratory demonstration 4

Description:
Laboratory demonstration of the vibration isolation phenomena.

Specific objectives:
To use vibration signals for characterising a vibration isolation system experimentally.

Delivery:
Report laboratory demonstration 4.

Full-or-part-time: 12h 30m
Laboratory classes: 3h 30m
Self study: 9h

Submission of proposed exercices

Description:
Submission of exercices proposed by the lecturers

Specific objectives:
Capability of solving the proposed problems.

Delivery:
Resolution of the proposed problems.

Full-or-part-time: 18h
Self study: 18h

Mid-course exam

Description:
Mid-course exam of the subject

Specific objectives:
Evaluation of the student's understanding of the concepts and methods presented during the first half of the course.

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

End-course exam

Description:
End-course exam of the subject.

Specific objectives:
Evaluation of the student's understanding of the concepts and methods presented in the course.

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

GRADING SYSTEM

The final mark of this course is obtained from the following calculation:
Final mark = 0.1*PP + 0.3*IL + 0.25*EP + 0.35*EF
where the capital letter refer to the following activities:
PP: Proposed problems
IL: Laboratory demonstration reports
EP: Mid-course exam
EF: End-course exam

Those students that meet the requirements can take the reevaluation exam (ER). The mark obtained in this exam will replace the marks obtained in the partial and final exam only when the new final mark is higher than the initial one, that is, if 0.6*ER > 0.25*EP + 0.35*EF. If the new final mark is equal or higher than 5, the final mark of the course will be a 5.

EXAMINATION RULES.

The course exams will be individual exams. The student will be allowed to bring the course notes to the exam. It will be strictly forbidden to use smartphones or any other way of telecommunication during the exam. The laboratory reports will be done in groups. These reports will have to follow the report writing instructions that will be given during the course.

BIBLIOGRAPHY

Basic:
- Budynas, R. G.; Nisbett, J. K. Diseño en ingeniería mecánica de Shigley [on line]. 10a ed. México: McGraw-Hill, 2019 [Consultation: 15/06/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=5485813. ISBN 9781456267568.
- Salueña, X.; Nápoles, A. Tecnología mecánica [on line]. 2ª ed. Barcelona: Edicions UPC, 2001 [Consultation: 08/01/2016]. Available on: http://hdl.handle.net/2099.3/36437. ISBN 8483014491.
- Den Hartog, J. P. Mechanical vibrations. New York: Dover Publications, 1984. ISBN 0486647854.
- Thomson, William Tyrrell. Theory of vibration with applications. 4th ed. Cheltenham: Nelson Thornes, cop. 1993. ISBN 0748743804.

RESOURCES

Other resources:
Course notes provided by the lecturer. Laboratory handouts.