

Course guide

330806 - TM - Maintenance Technologies

Last modified: 07/07/2026

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

Degree: MASTER'S DEGREE IN INDUSTRIAL FACILITY DESIGN AND MANAGEMENT (Syllabus 2026). (Compulsory subject).

Academic year: 2026 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Fakhraei, Javad

Others: Fakhraei, Javad

TEACHING METHODOLOGY

Theory, problem-solving and software simulation lectures: These sessions are not intended to provide an exhaustive mathematical treatment of the subject; rather, they aim to offer students a comprehensive overview while emphasizing the fundamental concepts required for a solid understanding of the course material. During the lectures, theoretical aspects will be discussed alongside standard problems and conceptual questions to reinforce comprehension. Problem-solving activities conducted during face-to-face sessions are designed to help students develop the ability to analyze problems critically, identify the key elements involved, and apply appropriate solution strategies. Additionally, a range of real engineering problems will be examined in detail, accompanied by the presentation and analysis of corresponding software outputs. Prior to each in-person session, lecture notes and a set of proposed problems will be made available to students through the virtual classroom with sufficient advance notice. Students are required to read the theoretical material before attending the session, and their preparation may be assessed through questions posed during class.

- Problem assignments: Students must independently solve and submit the proposed problem sets within the established deadlines.
- Tutorials, individual study, and teamwork: The course also includes tutorial sessions, independent study, and both individual and collaborative work aimed at reinforcing the learning process and developing analytical and problem-solving skills.
- Examinations and assessment: Student performance will be evaluated through examinations, assessment tests, submitted assignments and final project deliveries including reports and software simulation outputs.

LEARNING OBJECTIVES OF THE SUBJECT

Knowledge

- M4.K1: Describe the main failure modes in an industrial installation, as well as the most common detection tools.
- M4.K3: Classify the types of signals that can be extracted from an industrial installation and the information gathering mechanisms useful for its maintenance.
- M4.K4: Describe the basic principles and tools used for predictive maintenance based on data monitoring and real-time analysis.

Skills

- M4.S1: Evaluate the reliability of a measurement chain.
- M4.S2: Evaluate the condition of an industrial installation from a maintenance perspective.

STUDY LOAD

Type	Hours	Percentage
Hours large group	45,0	100.00

Total learning time: 45 h

CONTENTS

Vibration of multi degree-of-freedom systems

Description:

The goals of vibration analysis of Multi-Degree-of-Freedom (MDOF) systems are essentially to understand, predict, and control the dynamic behavior of complex mechanical structures that have multiple interacting masses, stiffnesses, and damping elements.

Specific objectives:

Determination of natural frequencies and mode shapes, Prediction of free and forced vibration responses, Understanding differences between linear and nonlinear vibration responses.

Related activities:

A1, A3, A8

Full-or-part-time: 35h

Theory classes: 13h 20m

Practical classes: 11h 40m

Self study : 10h

Vibration of continuous systems

Description:

The goals of vibration analysis of continuous systems (also called distributed-parameter systems) focus on understanding the dynamic behavior of structures where mass and stiffness are continuously distributed in space, such as beams, plates, shells, and membranes.

Specific objectives:

Determination of natural frequencies and mode shapes, Solving governing partial differential equations, Understanding wave propagation phenomena, Prediction of dynamic response to external loading

Related activities:

A2, A3, A8

Full-or-part-time: 30h

Theory classes: 10h

Practical classes: 10h

Self study : 10h

Fundamentals of acoustic

Description:

The goals of learning the fundamentals of acoustics are to develop a solid theoretical and practical understanding of how sound is generated, propagates, and interacts with media and boundaries, and to apply this knowledge in engineering and scientific contexts.

Specific objectives:

Understanding the nature of sound, governing acoustic equations, analyzing sound propagations, develop analytical and modeling Skills

Related activities:

A4, A7, A8

Full-or-part-time: 30h

Theory classes: 10h

Practical classes: 10h

Self study : 10h

Signal processing

Description:

The goals of learning signal processing in maintenance focus on enabling engineers to extract meaningful information from measured data, specifically vibration and acoustic signals) in order to monitor, diagnose, and predict the condition of machines and systems.

Specific objectives:

Types of signals, signal acquisition, signal processing and analysis

Related activities:

A6, A7, A8

Full-or-part-time: 15h

Theory classes: 5h

Practical classes: 5h

Self study : 5h

Experimental information on mechanical and acoustical quantities

Description:

This topic introduces the experimental measurement of mechanical and acoustical quantities such as displacement, velocity, acceleration, sound power and intensity. Students learn how these physical variables are obtained in real engineering systems, with emphasis on practical applications in vibration and acoustics.

Specific objectives:

Importance of measuring vibration and noise, Vibration and noise Measurement Schemes, vibrometers, accelerometers

Related activities:

A5, A7, A8

Full-or-part-time: 15h

Theory classes: 5h

Practical classes: 5h

Self study : 5h

ACTIVITIES

Title of activity 1: Vibration resolutions of mechanical systems with multiple degrees of freedom.

Description:

Detailed analysis of mechanical systems with multiple degrees of freedom will be conducted in the context of both theoretical and problem-solving parts. The dynamic behaviors of some mechanical systems will be simulated with MATLAB software.

Specific objectives:

Once the activity is finished, the student must be able to design and interpret vibrations in a systems with multiple degrees of freedom.

Delivery:

Delivery of solved problems.

The evaluation of this activity together with the other activities will form part of the evaluation as specified in the corresponding section of the qualification system.

Full-or-part-time: 30h

Theory classes: 10h

Practical classes: 10h

Self study: 10h

Title of activity 2: Solving problems of vibrations in continuous systems

Description:

Vibrations in continuous systems will be dimensioned and studied for the cases of strings, beams and plates.

Specific objectives:

Once the activity is finished, the student must be able to analyze and identify detailed vibrational concepts in continuous systems.

Material:

References books and teacher's notes.

Delivery:

Delivery of solved problems.

The evaluation of this activity together with the other activities will form part of the evaluation as specified in the corresponding section of the qualification system.

Full-or-part-time: 30h

Theory classes: 10h

Practical classes: 10h

Self study: 10h

Title of activity 3: First partial test of the continuous assessment.

Description:

Individual test in the classroom with a part of the theoretical concepts studied, and solving exercises and problems related to the learning objectives.

Specific objectives:

At the end of this activity the student should be able to:

Know, understand and apply the concepts studied in the theoretical sessions so far.

Material:

Notes, statements and calculator.

Delivery:

Resolution of the test.

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

Full-or-part-time: 7h

Theory classes: 2h

Self study: 5h

Title of activity 4: Study on basic concepts of acoustic and understanding sound wave propagation in acoustic medium.

Description:

Learning acoustic wave propagation including radiation and scattering phenomena, calculation of sound pressure level and insertion loss.

Specific objectives:

Once the activity is finished, the student must be able to determine, compute and simulate sound wave propagations in acoustic mediums.

Material:

Reference books and teacher's notes.

Delivery:

Delivery of solved problems.

The evaluation of this activity together with the other activities will form part of the evaluation as specified in the corresponding section of the qualification system.

Full-or-part-time: 10h

Theory classes: 3h 20m

Practical classes: 3h 20m

Self study: 3h 20m

Title of activity 5: Developing ability to acquire, interpret, and analyze experimental data related to mechanical vibration and acoustic quantities.

Description:

Conducting different exercises and real engineering experimental tests involving vibration and noise recording and analyzing through accelerometers, vibrometers and microphone.

Specific objectives:

Once the activity is finished, the student must know how to interpret and analyze experimental data via accelerometers.

Material:

Teacher's notes.

Delivery:

In addition to delivery of the solved problems, students must prepare a report of the practice carried out, according to the instructions indicated and deliver to the teacher in the set time.

The evaluation of this activity together with the other activities will form part of the evaluation as specified in the corresponding section of the qualification system.

Full-or-part-time: 10h

Theory classes: 3h 20m

Practical classes: 3h 20m

Self study: 3h 20m

Title of activity 6: Signal classifications and analysis methods

Description:

This activity presents different types of signals (deterministic, random, periodic, transient, etc.) and some of their analysis methods. Students learn how to analyse signals in the time domain, frequency domain (Fourier transform, spectra)

Specific objectives:

Once the activity is finished, the student must know different types of signals and some of their analysis methods. Students learn how to analyse signals in the time domain, frequency domain (Fourier transform, spectra).

Material:

References books and teacher's notes.

Delivery:

Students must deliver problems feedback, according to the instructions indicated and deliver to the teacher.

The evaluation of this activity together with the other activities will form part of the evaluation as specified in the corresponding section of the qualification system.

Full-or-part-time: 10h

Theory classes: 3h 20m

Practical classes: 3h 20m

Self study: 3h 20m

Title of activity 7: Second partial test of the continuous assessment.

Description:

Individual test in the classroom with a part of the theoretical concepts studied, and solving exercises and problems related to the learning objectives.

Specific objectives:

At the end of this activity the student should be able to:

Know, understand and apply the concepts studied in the theoretical sessions so far.

Material:

Notes, statements and calculator.

Delivery:

Resolution of the Test.

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

Full-or-part-time: 6h

Theory classes: 1h

Self study: 5h

Title of activity 8: Final test

Description:

Individual test in the classroom with a part of the theoretical concepts studied, and solving exercises and problems related to the learning objectives.

Material:

Statement and Calculator.

Delivery:

Resolution of the test.

The evaluation of this activity will form entire evaluation as specified in the corresponding section of the teaching guide.

Full-or-part-time: 20h

Theory classes: 5h

Self study: 15h

GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the [Action Framework for Academic Integrity in Assessment at the UPC](#).

Delivery of the Proposed Problems: 10% of the grade for the course.

- First Partial Continuous Assessment Test: 40% of the grade for the subject.
- Second Partial Continuous Assessment Test: 35% of the grade for the subject.
- Attendance to the practices (5%) and the preparation of project reports (10%) related to the results obtained in said practices: 15% of the grade for the subject.

Therefore, the Note for Partial Tests (NPP) = 40% * (First Written Test Note) + 35% * (Second Written Test Note) + 15% * (Practice Note) + 10% * (Delivery Note of the proposed Problems).

It is important to note that the partial written tests are liberating, in such a way that, if the student obtains an $NPP > 4.95$, he will be exempted from passing the final test. Students who fail to pass the course by partial exams or those who want to improve their grade will have a second chance with a new final test.

The Final Test Score (NPF) = 100% * (Final Written Test Score). Thus, the final grade of the Subject = MAX (NPP: NPF).

EXAMINATION RULES.

Successful completion of the course requires mandatory attendance and participation in all scheduled activities and completion of all assigned problem sets within the specified deadlines. Any activity that is not completed or submitted will automatically receive a grade of zero.

- In completing the assigned problem sets, students are expected to apply the concepts and methodologies presented during the lecture sessions. Students may consult the instructor to clarify any questions or difficulties encountered during the process. Submission deadlines of the the requested problems will be announced in advance, and late submissions will not be accepted under any circumstances.
- For the assigned problem sets, any total or partial copying of solutions will result in failure of the corresponding activity. Students are responsible for ensuring the confidentiality and security of their own work and materials.
- The use of formula sheets, notes, or any supplementary reference materials will not be permitted during either the midterm assessments or the final examination under any circumstances.



BIBLIOGRAPHY

Basic:

- Rao, Singiresu S. Mechanical vibrations. 6th ed. Harlow: Pearson Education, 2018. ISBN 9781292178608.
- Morse, Philip M. ; Uno Ingard, K. Theoretical acoustics. Prenticeon University Press, 1986. ISBN 0691024014.