

Course guide

240IME32 - 240IME32 - Machine Testing

Last modified: 16/05/2023

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

Degree: MASTER'S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2012). (Optional subject).
MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2019). (Optional subject).
MASTER'S DEGREE IN RESEARCH IN MECHANICAL ENGINEERING (Syllabus 2021). (Optional subject).

Academic year: 2023 **ECTS Credits:** 4.5 **Languages:** Catalan

LECTURER

Coordinating lecturer: Puig Ortiz, Joan

Others: Salvadó Escuer, Pau
Sanchís Estruch, Ricard

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEMEI03. Ability for the design and assays in machines.
CEEMEC5. Analyse the dynamic phenomenon and its formulation for its application in the development of all and each one of the planning, design and calculation of mechanical elements stages.

TEACHING METHODOLOGY

LEARNING OBJECTIVES OF THE SUBJECT

General:

- Provide basic training in the field of measurement and analysis of mechanical magnitudes, especially dynamic, as well as introduce students in the field of machine and components testing that are usually performed at different stages of development of new products and the industrial environment in general.

Specific:

- To be aware of the importance of machine testing in all the areas of mechanical engineering: development of new products and machinery, research, manufacturing processes control, maintenance, etc.
- To know the concept of standardization and their influence in industrial testing.
- To know the basic techniques for the measurement and analysis of mechanical variables.
- To be able to carry out real measurements in laboratories. To know the basic instrumentation and the proper analysis techniques for every situation.
- To be able to design testing procedures and protocols, i.e. documents that summarize all the stages and requirements of testing: rig and instrumentation requirements, evaluation criteria and standards related to tests.

STUDY LOAD

| Type | Hours | Percentage |
|-------------------|-------|------------|
| Hours large group | 27,0 | 24.00 |
| Self study | 72,0 | 64.00 |
| Hours small group | 13,5 | 12.00 |

Total learning time: 112.5 h

CONTENTS

1. INTRODUCTION. TESTING AND MEASUREMENT

Description:

- Why testing?
- Testing through all the steps of R+D: prototyping.
- Testing during manufacturing and trading: quality control and verification.
- Testing during service: control and maintenance.
- Test procedures: requirements, methodology, data handling, acceptance levels and standards. Regulations.
- Prototyping: prototyping function at different stages of mechanical design.
- Rapid prototyping and virtual prototyping (simulations).

Full-or-part-time: 8h 30m

Theory classes: 1h 30m

Practical classes: 1h 30m

Self study : 5h 30m

2. EXPERIMENTAL DATA

Description:

- Static and dynamic mechanical magnitudes. Units.
- Linear and logarithmic scales.
- Relative units and reference levels.
- Measurements reliability: precision, accuracy and resolution.
- Repeated and random errors. Statistical evaluation of random errors.
- Calibration: standards.
- Uncertainty analysis.
- Parameters fit.
- Error propagation.

Full-or-part-time: 16h 30m

Theory classes: 3h

Practical classes: 3h

Self study : 10h 30m

3. MEASUREMENT SYSTEM

Description:

- Elements of a measurement system. Types of transducers.
- Properties: sensitivity, repeatability, linearity, dynamic range, frequency range, time and frequency response function.
- Static and dynamic calibration.
- Transverse sensitivity.
- A-D conversion.
- Estimation of the accuracy of a measurement system: uncertainty analysis.

Full-or-part-time: 37h 30m

Theory classes: 6h

Practical classes: 3h

Laboratory classes: 4h 30m

Self study : 24h

4. DYNAMIC MEASURES ANALYSIS

Description:

- Amplitude domain analysis: density and probability distribution.
- Cycle counting techniques, "Rainflow". Fatigue testing.
- Time domain analysis: power and energy of a signal; correlation.
- Frequency domain analysis: Fourier Series and Fourier Transform, power and energy spectral densities, filters and time windowing.
- Signal analysis applications: Predictive maintenance techniques.

Full-or-part-time: 41h 30m

Theory classes: 7h 30m

Practical classes: 3h

Laboratory classes: 4h 30m

Self study : 26h 30m

5. TEST RIGS

Description:

- Test rigs: types and characteristics.
- Brake dynamometers.

Full-or-part-time: 8h 30m

Theory classes: 3h

Self study : 5h 30m

GRADING SYSTEM

BIBLIOGRAPHY

Basic:

- Martínez Miralles, Jordi; Puig Ortiz, Joan. Apunts d'assaig de màquines. 2003. ISBN 8468821012.
- Figliola, R. S; Beasley, Donald E. Theory and design for mechanical measurements. 4th ed. New York [etc.]: John Wiley & Sons, cop. 2006. ISBN 9780471445937.
- Agulló i Batlle, Joaquim; Cardona i Foix, Salvador. Anàlisi de senyals. Barcelona: Servei de Publicacions de la UPC, 1992. ISBN 8476531915.
- Beckwith, T.G; Marangoni, Roy D; Lienhard, John H. Mechanical measurements. 6th ed. Reading [etc.]: Addison-Wesley, 2006. ISBN 9780201847659.
- Wheeler A. J. ; Ganji A. R. Introduction to Engineering Experimentation. 3rd ed. New York: Prentice Hall, 2010. ISBN 9780131742765.

Complementary:

- Martín i Batlle, M.; Roure, F.; Sanz i Rúbies, J. Extensometria [on line]. Barcelona: Universitat Politècnica de Catalunya, 1992 [Consultation: 09/09/2022]. Available on: <https://upcommons.upc.edu/handle/2099.3/36539>. ISBN 8476532342.
- Bentley, John P. Principles of measurement systems. 4th ed. New York: Pearson Prentice Hall, cop. 2005. ISBN 0130430285.
- Newland, D. E. An Introduction to Random vibrations, spectral and wavelet analysis [on line]. Mineola: Dover, 2005 [Consultation: 07/10/2020]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1894605>. ISBN 0486442748.
- Girdhar, P. ; C. Scheffer [eds]. Practical machinery vibration analysis and predictive maintenance [on line]. Amsterdam: Newnes, 2004 [Consultation: 29/03/2023]. Available on: <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=293533>. ISBN 0750662751.
- Regtien, P.P.L; Finkelstein, Ludwik. Measurement science for engineers [on line]. London [etc.]: Kogan Page Science, cop. 2004 [Consultation: 20/04/2023]. Available on: <https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/9781903996584/measurement-science-for-engineers>. ISBN 9781903996584.