

## 240IME32 - Machine Testing

Coordinating unit:	240 - ETSEIB - Barcelona School of Industrial Engineering		
Teaching unit:	712 - EM - Department of Mechanical Engineering		
Academic year:	2019		
Degree:	MASTER' S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2019). (Teaching unit Optional) MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Teaching unit Optional) MASTER'S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2012). (Teaching unit Optional)		
ECTS credits:	4,5	Teaching languages:	Catalan

### Teaching staff

Coordinator:	Puig Ortiz, Joan
Others:	Pàmies Vilà, Rosa

### 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.

### 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.



## 240IME32 - Machine Testing

### Study load

Total learning time: 112h 30m	Hours large group:	27h	24.00%
	Hours small group:	13h 30m	12.00%
	Guided activities:	0h	0.00%
	Self study:	72h	64.00%

## 240IME32 - Machine Testing

### Content

<p>1. INTRODUCTION. TESTING AND MEASUREMENT</p>	<p>Learning time: 8h 30m Theory classes: 1h 30m Practical classes: 1h 30m Self study : 5h 30m</p>
<p>Description:</p> <ul style="list-style-type: none"> <li>- Why testing?</li> <li>- Testing through all the steps of R+D: prototyping.</li> <li>- Testing during manufacturing and trading: quality control and verification.</li> <li>- Testing during service: control and maintenance.</li> <li>- Test procedures: requirements, methodology, data handling, acceptance levels and standards. Regulations.</li> <li>- Prototyping: prototyping function at different stages of mechanical design.</li> <li>- Rapid prototyping and virtual prototyping (simulations).</li> </ul>	
<p>2. EXPERIMENTAL DATA</p>	<p>Learning time: 16h 30m Theory classes: 3h Practical classes: 3h Self study : 10h 30m</p>
<p>Description:</p> <ul style="list-style-type: none"> <li>- Static and dynamic mechanical magnitudes. Units.</li> <li>- Linear and logarithmic scales.</li> <li>- Relative units and reference levels.</li> <li>- Measurements reliability: precision, accuracy and resolution.</li> <li>- Repeated and random errors. Statistical evaluation of random errors.</li> <li>- Calibration: standards.</li> <li>- Uncertainty analysis.</li> <li>- Parameters fit.</li> <li>- Error propagation.</li> </ul>	
<p>3. MEASUREMENT SYSTEM</p>	<p>Learning time: 37h 30m Theory classes: 6h Practical classes: 3h Laboratory classes: 4h 30m Self study : 24h</p>
<p>Description:</p> <ul style="list-style-type: none"> <li>- Elements of a measurement system. Types of transducers.</li> <li>- Properties: sensitivity, repeatability, linearity, dynamic range, frequency range, time and frequency response function.</li> <li>- Static and dynamic calibration.</li> <li>- Transverse sensitivity.</li> <li>- A-D conversion.</li> <li>- Estimation of the accuracy of a measurement system: uncertainty analysis.</li> </ul>	

## 240IME32 - Machine Testing

4. DYNAMIC MEASURES ANALYSIS	Learning time: 41h 30m Theory classes: 7h 30m Practical classes: 3h Laboratory classes: 4h 30m Self study : 26h 30m
<p>Description:</p> <ul style="list-style-type: none"><li>- Amplitude domain analysis: density and probability distribution.</li><li>- Cycle counting techniques, "Rainflow". Fatigue testing.</li><li>- Time domain analysis: power and energy of a signal; correlation.</li><li>- Frequency domain analysis: Fourier Series and Fourier Transform, power and energy spectral densities, filters and time windowing.</li><li>- Signal analysis applications: Predictive maintenance techniques.</li></ul>	
5. TEST RIGS	Learning time: 8h 30m Theory classes: 3h Self study : 5h 30m
<p>Description:</p> <ul style="list-style-type: none"><li>- Test rigs: types and characteristics.</li><li>- Brake dynamometers.</li></ul>	

## 240IME32 - Machine Testing

### Bibliography

#### Basic:

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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. 5th ed. Reading [etc.]: Addison-Wesley, 1993. ISBN 0201569477.

Wheeler A. J. ; Ganji A. R. Introduction to Engineering Experimentation. 3rd ed. New York: Prentice Hall, 2010. ISBN 9780131742765.

#### Complementary:

Martín i Batlle, Mateu; Roure Fernández, Francesc; Sanz i Rúbies, Jesús. Extensometria [on line]. Barcelona: Universitat Politècnica de Catalunya, 1992 [Consultation: 04/09/2015]. Available on: <<http://hdl.handle.net/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. Mineola: Dover, 2005. ISBN 0486442748.

Girdhar, Paresh ; Scheffer, C. Practical machinery vibration analysis and predictive maintenance [on line]. Amsterdam [etc.]: Newnes, cop. 2004 [Consultation: 22/04/2016]. Available on: <<http://site.ebrary.com/lib/upcatalunya/detail.action?docID=10128091>>. ISBN 9780750662758.

Regtien, P.P.L; Finkelstein, Ludwik. Measurement science for engineers [on line]. London [etc.]: Kogan Page Science, cop. 2004 [Consultation: 17/09/2015]. Available on: <<http://www.sciencedirect.com/science/book/9781903996584>>. ISBN 9781903996584.