DIPLOMA IN ADVANCED APPLIED TECHNOLOGIES FOR INDUSTRY

Module Description
ADVANCED MACHINE DESIGN

Total contact hours	45
ECTS	5 (6 UC credits)
Taught by	Prof. Dr. Fernando Viadero Rueda –Coordinator– Prof. Pablo García Fernández
Learning goals related to	**Technical Competence:** This course presents theoretical and practical approaches in order to acquire the basic knowledge in structural dynamics problems that appears in mechanical machine design. Theoretical aspects are introduced as they are needed to help understand the machine mechanical behaviour. The aim of the course is to cover more of the typical engineering problems in structural machine dynamics. This module provides a broad overview of the definitions, concepts and professional techniques that includes two main areas of study, theoretical and experimental, related with machine dynamics. The aim of the subject Advanced Machine Design is to offer a complete vision of the techniques involved around dynamics machine design. **Methodological Competence:** This course will take an analytical and practical approach to structural dynamics in machine design, but there will be a strong focus on the application and practical studies in both the laboratory and the course work. All students are expected to actively participate in class and laboratory class. Many classes are interactive, and based around the use of a commercial Finite Element Method program in dynamic problems. **Personal Skills:** The course will consist of lectures on the basic material coupled with examples and the use of commercial software for the application to practical problems..
Content	1. **Introduction to Advanced Machine Design** - Course planning - Concept and course schedule - Theoretical and experimental methods. - CAE today. - Strategies for CAE integration. **2. Introduction to structural Dynamics** - Kinematics of inertial and local systems. - Dynamic equilibrium general equation. - Mass matrices - Boundary conditions - The dynamic analysis process

	3. Free vibrations of non damped systems - Frequencies and modes of vibration. - Modes properties. - Modal analysis. **4. Free vibrations of damped systems** - Free vibrations with proportional damping - Diagonaliced damping matrices - Free vibrations with non proportional damping - Damping practical aspects **5. Forced response. Modal superposition I** - Forces vector - Modal superposition - Truncation frequency - Truncated modal superposition - Dynamic matrix - Other considerations **6. Numerical integration of the dynamic equations.** - Preliminary considerations - Explicit methods - Wilson-θ method - Newmark method. - Convergence study. **7. Condensation methods.** - Static condensation methods. - Guyan condensation - Dynamic condensation - Rayleigh methods - Subspace iteration method **8. Experimental analysis of vibrations** - Vibration experimental analysis applications. - Measurements methods. - FFT algorithm. - Digital signals. **9. Introduction to experimental modal analysis** - Introduction. - Experimental modal analysis applications. - FRF of 1 dof systems. - Measurements techniques.
Teaching material	▪ **Texts:** Avilés, R. Métodos de análisis para diseño mecánico. Publicaciones ESI Bilbao. 2002. Clough, R. W.; Penzien, J. Dynamics of structures. Mc Graw Hill, 1975. Humar, J. L. Dynamics of structures, Prentice Hall, 1990. Knight, C. E., The Finite Element Method in Mechanical Design, PWS-KENT Publishing Co., 1993. Kardestuncer, H. Finite Element Handbook, Mc Graw Hill, 1988.

	Petyt, M. Introduction to finite element vibration analysis, Cambridge University Press, 1990. Bathe, K. J. Finite element procedures in engineering analysis. Prentice Hall, 1982. Newland, D. E. An introduction to random vibrations, spectral and wavelet analysis. Prentice Hall, 1996.
Teaching methods	▪ The class will consist of lectures on the basic material coupled with examples and applications to some problem set for each section. ▪ The content of the laboratory classes is structured to provide a varied learning environment. Participants will be encouraged to share their experiences and ideas and work with others to explore the possibilities of usinf a commercial finite elements software. The module will be conducted using a mixture of small group activities; practical exercises, case studies, facilitated discussions and oral presentations.
Assessment	Student's presentations, group work activities and written exam

Workload	Magistral class	20
	Laboratory class	25
	Laboratory works	30
	Tutorials	25
	Preparation for a final written assignment:	25
International aspects	▪ Use of international examples and teaching material	
Cross-cultural reference	▪ Participants of international origin. (normally)	
Course language	▪ English	