Universidad Carlos III de Madrid
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COURSE: Aeroelasticity		
DEGREE: Aerospace Engineering	**YEAR: 4th**	**TERM: 1st**

La asignatura tiene 29 sesiones que se distribuyen a lo largo de 14 semanas. Los laboratorios pueden situarse en cualquiera de ellas. Semanalmente el alumnos tendrá dos sesiones, excepto en un caso que serán tres

WEEKLY PLANNING

WEEK	SESSION	DESCRIPTION	GROUPS (mark X)		SPECIAL ROOM FOR SESSION (Computer class room, audio-visual class room)	Indicate YES/NO If the session needs 2 teachers	WEEKLY PROGRAMMING FOR STUDENT		
			LECTURES	SEMINARS			DESCRIPTION	CLASS HOURS	HOME WORK HOURS (Max. 7h week)
1	1	**Aeroelasticity & Dynamic Loads. Getting Started**. - Aeroelasticity as a multidisciplinary task - Normal modes at a glance - Stability problems vs. Response problems - Basic flutter mechanisms. CS25.629	**X**				Reading corresponding notes chapters	1,6	1
2	2	**2D Aeroelasticity: fixing concepts with some analytical 2D solutions** - The ¾ span aerofoil. Pitch and plunge modes. - Revisiting steady aerodynamics. The standard atmosphere. - Introduction to 2D unsteady aerodynamics. Wagner, Küssner, Theodorsen. - Solution of the 2D aeroelastic equation. - Sensitivity to Xcg.	**X**				Reading corresponding notes chapters Study and personal work about the lecture	1,6	2

3	3	**2D & 3D Static aeroelasticity: divergence and control reversal** - Static aeroelasticity of a 2D rigid aerofoil. - Static aeroelasticity of a fixed wing - Divergence. Effect of sweep angle on divergence speed. - Control effectiveness. Effect of wing flexibility on control effectiveness. **PROPOSAL OF HOMEWORK 1**	**X**				Reading corresponding notes chapters Study and personal work about the lecture	1,6	3
4	4	**3D Aeroelasticity: The structural model & the normal modes** - Revisiting 1 d.o.f system. - Multiple d.o.f. systems - The Finite Element Method (FEM) for structural analysis. - From stick models to full FEM models. The stiffness matrix. - Mass models. The mass matrix. - Condensation. - Structural Normal modes. Frequencies and mode shapes. **HOMEWORK 1 DELIVERY**	**X**				Reading corresponding notes chapters Study and personal work about the lecture Work on HM01	1,6	7
5	5	**The experimental modal analysis and the GVT. Dynamic model validation.** - Ground Vibration Test (GVT) description. - Introduction to Digital Signal Processing (DSP). The Fast Fourier Transform (FFT). - Experimental Modal Analysis. - Comparison between test and simulations. MAC. - Updating FEM model to match GVT results.	**X**				Reading corresponding notes chapters Study and personal work about the lecture	1,6	2
6	6	**3D Aeroelasticity: unsteady aerodynamics, origins (Wagner, Küssner, Theodorsen). Rodden and the Doublet Lattice Method (DLM)** - Continuing with 2D unsteady aerodynamics. - The Finite Element Method (FEM) for aerodynamic analysis. - Rodden and the Doublet lattice Method - Aerodynamic corrections to match wind tunnel or flight tests.	**X**				Reading corresponding notes chapters Study and personal work about the lecture	1,6	5
7	7	**Partial Exam 1: Aeroelastic Modelling** **The flutter equation and its solution (natural aircraft)** - Derivation of flutter equation from Lagrange equations. - Complex matrix eigenvalues & eigenvector solution. - Evolution of modal frequency and modal damping with flight speed. - The V-g plot unveiled - Physical description of classical lifting surface flutter mechanisms - Airworthiness regulations CS25.629 (and the evolution from FAR 25.629 and JAR 25.629)	**X**				Reading corresponding notes chapters Study and personal work about the lecture	1,6	7
8	8	**Flutter speed sensitivities. Control surface massbalance. Aeroservoelasticity (coupling**	**X**				Reading corresponding	1,6	2

		with Flight Control System laws) - Sensitivity analyses: mass configuration, Mach number, control surface aerodynamic hinge moment, etc. - Physical description of classical control surface flutter mechanisms. - Sensitivity to control surface mass balance. - Covering uncertainties & addressing failure cases (structural single failures, damage tolerance, water ingress, composite delaminations...) - Revisiting aircraft controls. Introduction to aircraft flight control system laws. - Aeroservoelasticity. - Physical description of most common aeroservoelastic couplings.					notes chapters Study and personal work about the lecture		
9	9	**Flight Flutter Test. Aeroelastic model validation. Wrap up of aeroelastic stability problems.** - Flight Flutter Test (FVT) description. - Aircraft response to control surface sweeps and pulses. - Revisiting Digital Signal Processing (DSP). Noise treatment. Averaging. Windowing. Aliasing. Leakage,... - Experimental Modal Analysis applied to Flight Test. - Comparison between flight test and simulations. Scatter. - Wrap up of aeroelastic stability problems.	**X**				Reading corresponding notes chapters Study and personal work about the lecture	1,6	5
10	10	**Partial Exam 2: Aeroelastic Stability** **The concept of loads. Monitoring stations. Checkstress loads and fatigue loads. Dynamic loads and why they are different form static loads. Structural response to transient excitation.** - What is fast and what is slow - Direct response vs. Modal response - Frequency domain response - Time domain response	**X**				Reading corresponding notes chapters Study and personal work about the lecture	1,6	7
11	11	**Ground dynamic loads: dynamic landing & Taxi** - Relevance of the dynamic landing and taxi scenarios. Insight into the airworthiness regulations. - Dynamic Landing Loads equations. Spin-up and spring back. - Taxi loads equations. Coupling landing gear and complete aircraft. - Solution. Relevant parameters. - Complete loads loop process. - Validation: Landing Gear (L/G) Drop Test. Hard landings. (1-cos) taxi tests. Unpaved surfaces taxi tests. - Where the structure is sized by dynamic landing. By Taxi, EBH curves for operation in unpaved surfaces. **PROPOSAL OF HOMEWORK 2**	**X**				Reading corresponding notes chapters Study and personal work about the lecture	1,6	2

12	12	**Dynamic flight loads: discrete tuned gust (DTG)** - The atmospheric turbulence. Discrete and continuous models - Relevance of the discrete tuned gust (DTG) analyses. Insight into the airworthiness regulations. - DTG equation. The spiral gust column. Solution. Relevant parameters. - Complete DTG loads loop process. - Validation: FVT. Description of where the structure is sized by DTG. Round the clock and multiaxis.	**X**				Reading corresponding notes chapters Study and personal work about the lecture Work on HW02	1,6	5
13	13	**Dynamic flight loads: continuous turbulence (CT)** - Relevance of the Continuous Turbulence analyses. Insight into the airworthiness regulations. The von Karman spectrum. - CT equation. Frequency domain solution using Power Spectral Density (PSD). - The contribution of the rigid body modes. Solution. Relevant parameters. - Complete CT loads loop process. - Validation: FVT. Description of where the structure is sized by CT. **HOMEWORK 2 DELIVERY**	**X**				Reading corresponding notes chapters Study and personal work about the lecture Work on HW02	1,6	7
14	14	**Dynamic flight loads: buffet. Wrap up of aeroelastic response problems.** - Relevance of the Buffet loads. - Wing buffet. HTP buffet. Fin buffet. L/G doors buffet. - Test to measure buffet response. - PSD technique to compute buffet loads.	**X**				Reading corresponding notes chapters Study and personal work about the lecture	1,6	7
15		**Partial Exam 3: Aeroelastic Response (Dynamic Loads)**						1,6	
							Subtotal 1	**24**	**62**
							Total 1 *(Hours of class plus student homework hours between weeks 1-14)*	**86**	

15		Tutorials, handing in, etc							
16		Assessment						**3**	**1**
17									
18									
							Subtotal 2	**3**	**1**
							Total 2 *(Hours of class plus student homework hours between weeks 15-18)*	**4**	

TOTAL *(Total 1 + Total 2. Maximum 90 hours)*	**90**