uc3m Universidad Carlos III de Madrid
Vicerrectorado de Estudios
Apoyo a la docencia y gestión del grado

COURSE: Turbomachinery Design		
DEGREE: Aerospace Engineering	YEAR: 4th	TERM: 1st

WEEKLY PLANNING

WEEK	SESSION	DESCRIPTION	TEACHING (mark X) LECTURES	TEACHING (mark X) SEMINARS	SPECIAL ROOM FOR SESSION (Computer class room, audio-visual class room)	WEEKLY PROGRAMMING FOR STUDENT DESCRIPTION	CLASS HOURS (1,66=50+50 min)	HOMEWORK HOURS (Max. Estim. 6,5h)
1	1	Introduction and dimensional analysis - Introduction to the subject. Course scheduling. - Definition of a turbomachine. - Specific Speed: machine selection. - Compressible gas flow relations. - Dimensional analysis. - Turbomachinery Basic Equations: Euler, definition of rothalpy. - Definition of adiabatic / polytropic efficiency. - Enthalpy-entropy diagrams.	X				1.66	6.5
	2	Exercises on dimensional analysis Exercises on Turbomachinery Basic Equations		X			1.66	

WEEKLY PLANNING								
WEEK	SESSION	DESCRIPTION	TEACHING (mark X)		SPECIAL ROOM FOR SESSION (Computer class room, audio-visual class room)	WEEKLY PROGRAMMING FOR STUDENT		
			LECTURES	SEMINARS		DESCRIPTION	CLASS HOURS (1,66=50+50 min)	HOMEWORK HOURS (Max. Estim. 6,5h)
2	3	Axial flow turbines: two-dimensional stage theory 1 - Dimensional analysis of a single turbine stage. - Thermodynamics of a turbine stage. - Total-to-total stage efficiency. - Row loss-stage efficiency relation. - Velocity triangles, loading and flow parameters, reaction: Repeating stage hypothesis.	X				1.66	6.5
	4	Axial flow turbines: problems #1 - Degree of reaction - Effect on efficiency. Optimum reaction. - Smith chart. Empirical versus reversible		X			1.66	
3	5	Axial flow turbines: two-dimensional stage theory #2 Estimation of turbine stage performance. Flow characteristics of a multistage turbine. Stresses in turbine rotor blades. Turbine blade cooling. Detailed design & Design criteria	X				1.66	6.5
	6	Axial flow turbines: problems #2		X			1.66	
4	7	Axial machines #1: introduction to cascade flow, Definition of streamsurface, m’-θ plane, blade-to-blade analysis. Cascade nomenclature. Airfoil theory, analysis of aerodynamic forces on turbomachinery blades, application of boundary layer theory to cascade forces	X				1.66	6.5
	8	LAB #1: Smith chart		X	computer		1.66	
5	9	Axial flow compressors and fans: 2D stage theory #1 - Dimensional analysis of a single compressor stage. - Thermodynamics of a compressor stage. - Total-to-total stage efficiency. Row loss-stage efficiency. - Velocity triangles, loading and flow parameters, reaction.	X				1.66	6.5

WEEKLY PLANNING								
WEEK	SESSION	DESCRIPTION	TEACHING (mark X)		SPECIAL ROOM FOR SESSION (Computer class room, audio-visual class room)	WEEKLY PROGRAMMING FOR STUDENT		
			LECTURES	SEMINARS		DESCRIPTION	CLASS HOURS (1,66=50+50 min)	HOMEWORK HOURS (Max. Estim. 6,5h)
	10	Axial flow compressors and fans: 2D stage theory #2 - Loading-Flow coefficient chart. Reaction choice. - Lift and Drag in terms of ϕ and ψ. - Diffusion Factor and solidity selection. - Estimation of compressor pressure ratio and efficiency.		X			1.66	
6	11	Axial flow compressors and fans: 2D stage theory #3 - Simplify off-design performance. - Compressor characteristic maps. - Stall and surge phenomena.	X				1.66	6.5
	12	Exercises on Axial Flow Compressors		X			1.66	
7	13	Two-Dimensional Cascades #1 - Cascade kinematics: velocity triangles. Cascade entalphy and entropy change: loss definitions. - Compressor cascade performance. Compressor characteristics: enthalpy rise, pressure recovery, deflection, deviation and loss. - Surface velocity distribution, diffusion factor. - Compressor cascade correlations: optimum solidity, polar curve. Diffusor efficiency	X				1.66	6.5
	14	Two-Dimensional Cascades #2 - Turbine cascade performance. Turbine characteristics: turning angle, Zweifel coefficient. - Surface velocity distribution: Back Surface Diffusion parameter. - Turbine cascade correlations: loss, optimum pitch-chord ratio	X				1.66	
8	15	LAB #2 - Airfoil design and introduction to MISES		X	computer		1.66	6.5
	16	Two-Dimensional Cascades: problems		X			1.66	

WEEKLY PLANNING								
WEEK	SESSION	DESCRIPTION	TEACHING (mark X)		SPECIAL ROOM FOR SESSION (Computer class room, audio-visual class room)	WEEKLY PROGRAMMING FOR STUDENT		
			LECTURES	SEMINARS		DESCRIPTION	CLASS HOURS (1,66=50+50 min)	HOMEWORK HOURS (Max. Estim. 6,5h)
9	17	Three-dimensional flow in Axial Turbomachines #1 - Theory of radial equilibrium. - The indirect problem: free-vortex flow, forced-vortex flow, general whirl distribution. - The direct problem	X				1.66	6.5
	18	LAB #3 - Cascade analysis with MISES		X	computer		1.66	
10	19	Three-dimensional flow in Axial Turbomachines #2 - Compressible flow through a blade-row. Constant specific mass flow. - Actuator disc approach. Blade-row interactions. - Computer methods solving through-flow problem - Secondary flows. Loss, angles and helicity. - Three-dimensional losses. Types and models. CFD analysis.	X				1.66	6.5
	20	Three-dimensional flow in Axial Turbomachines: problems		X			1.66	
11	21	Centrifugal compressors, fans and pumps #1 - Introduction, definitions and parts. - Optimum design of a centrifugal compressor inlet. - Slip factor. Correlations	X				1.66	6.5
	22	Centrifugal compressors, fans and pumps #2 - Performance of centrifugal compressors. - Diffuser system. Vane and vane-less diffusers. - Choking in a compressor stage	X				1.66	
12	23	Radial turbines #1 - Introduction. Types of inward flow radial turbine. - Thermodynamics of the 90 degrees IFR turbine - Basic rotor design. Rotor efficiency definition. Mach number relations. Loss coefficients.	X				1.66	6.5
	24	Centrifugal compressors, fans and pumps: problems		X			1.66	

WEEKLY PLANNING								
WEEK	SESSION	DESCRIPTION	TEACHING (mark X)		SPECIAL ROOM FOR SESSION (Computer class room, audio-visual class room)	WEEKLY PROGRAMMING FOR STUDENT		
			LECTURES	SEMINARS		DESCRIPTION	CLASS HOURS (1,66=50+50 min)	HOMEWORK HOURS (Max. Estim. 6,5h)
13	25	Radial turbines #2 - Optimum efficiency considerations. - Design considerations for rotor exit. - Incidence, clearance and windage losses. - Pressure ratio limits	X				1.66	6.5
	26	Radial turbines: problems		X			1.66	
14	27	Exam problems		X			1.66	6.5
	28	Labs presentation		X			1.66	
	29	LAB #4 - Experimental calculation of a compressor map		X	ab+computer		1.66	3.25
						Subtotal 1	**48**	**94**
						Total 1 *(Hours of class plus student homework)*	**142**	

15		Tutorials, handing in, etc					3.6	-
16 **17** **18**		Assessment					4	10
						Subtotal 2	**8**	**10**
						Total 2 *(Hours of class plus student homework)*	**18**	

TOTAL (*Maximun 160 horas*)	**160**