Universidad Carlos III de Madrid
www.uc3m.es

SUBJECT: Alternating current electrical machines		
Degree: Electrical Engineering	**YEAR: 3rd**	**TERM: 2nd**

WEEKLY SCHEDULE

Week	Ses.	SESSION CONTENT DESCRIPTION	Group		dist. aula	ses. 2 profs	STUDENT WEEKLY WORKLOAD		
			G	P			DESCRIPTION	H. PRES	H. TRAB
1	1	Course presentation. Subject content and structure. Evaluation rules. Types of electrical machines. Building and technological aspects of rotating electrical machines. IP, IM and IC codes. Thermal insulation classes		x	NO		Study of recommended bibliography	1,66	2,5
1	2	Ideal electrical machine. Analysis of the air-gap magnetic field. Diametral coil. Mechanical and electrical angles. Short-pitched and distributed coils. Distribution and pitch factor. Winding Factor. Numercal example. Spatial harmonics of the air-gap field.	x		NO		Study of recommended bibliography Problem AG2	1,66	2,5
2	3	Numerical exercises about machine windings.		x	NO		Problem AG4	1,66	2,5
2	4	AC current fed coil. Rotating magnetic field. Ferraris's Theorem. Flux per pole. Induced voltages in armature windings. Electrical current loading. Phase sequence and sense of rotation. Utilization factor. Rotor volume.	x		NO	SI	Study of recommended bibliography Problems AG5, AG7	1,66	2,5
3	5	More numerical exercises about windings. Leakage fuxes in electrical machines.		x	NO		Solving problems AG9, AG10, AG11	1,66	2,5
3	6	Description and technologial aspects of synchronous machines. Cooling and field excitation systems	x		NO		Study of recommended bibliography	1,66	2,5
4	7	No load operation. Load operation: armarture reaction. Equivalent circuit. Synchronous impedance. No load and short-circuit tests. Calculation of synchronous reactance. Linearisation.		x	NO		Problems MS1, MS2	1,66	2,5
4	8	Numerical examples. Calculation of field current from no load and short-circuit tests. Short circuit ratio and synchronous reactancia in p.u. values. Pure reactive load test. Phasor diagrams. **Problema MS1**.	x		NO		Study of recommended bibliography Problem MS4	1,66	2,5
5	9	Determination of the field current by Potier's method. Fundamentals and numerical example.		x	NO		Study of recommended bibliography Problem MS3, MS5	1,66	2,5
5	10	More numerical examples about saturated synchronous generator.	x		NO			1,66	2,5

6	11	Coupling to an infinite network. Synchronization. Torque-angle curve. Static stability limit. Operation at constant power and constant excitation on an infinite bus. Diagram of operational limits of the generator.		x	NO		Study of recommended bibliography	1,66	2,5
6	12	Labo session #1: Synchronization of a synchronous generator. P-Q regulation.	x		NO		Preparation of Labo session #1 report	1,66	2,5
7	13	Cilindrical rotor synchronous motor. Stability. Operational limits. Numerical examples.		x	NO		Study of recommended bibliography Problem MS9	1,66	2,5
7	14	More numerical examples of a synchronous machines connected to an infinite network. Generator and motor operation.	x		NO		Problem MS10, MS11	1,66	2,5
8	15	Two-reaction theory. Direct- and quadrature synchronous reactances. Phasor diagram of the salient pole synchronous machine. Determination of Xd and Xq. Slip test. Torque-angle curve.		x	NO		Study of recommended bibliography	1,66	2,5
8	16	More numerical examples on salient-pole synchronous machines.	x		NO		Study of recommended bibliography Problem MS18, MS20	1,66	2,5
9	17	Swing equation. Dynamic stability of the synchronous machine. Damping windings. Sudden short circuit. Transient reactances.		x			Study of recommended bibliography		
9	18	First intermediate test.	x		NO			1,66	2,5
10	19	Basic structure of induction machines. Squirrel cage and slip-ring rotor. Principle of operation. Synchronous speed, rotor slip and rotor frequency. Reduction to stator frequency and voltage. Induction motor equivalent circuits.		x	NO		Study of recommended bibliography	1,66	2,5
10	20	Losses and power balance in induction motors. Numerical examples.	x		NO		Problems MAS3, MAS7	1,66	2,5
11	21	Torque-speed characteristic. Numerical examples. Motor-, generator- and brake operation. Influence of supply voltage and rotor resistance on the torque-speed curve.		x	NO		Study of recommended bibliography Problems MAS8, MAS9	1,66	2,5
11	22	Labo session #2: Calculation of equivalent circuit parameters from test measurements	x		NO		Study of recommended bibliography Preparation of Labo session #2 report	. 1,66	2,5
12	23	Double cage and deep bar rotors. NEMA rotor types. The issue of direct-on-line starting. Starting methods: reduced voltage and increased impedance methods. Pole-changing speed variation. Variable frequency speed control methods. Constant torque and constant power ranges.		x	NO		Study of recommended bibliography Problems MAS10	1,66	2,5
12	24	Numerical examples on equivalent circuit analysis. Torque-speed characteristic. Breakdown torque and breakdown slip.	x		NO		Problem MS12	1,66	2,5
13	25	Selection of an induction motor for electrical drives, from manufacturers data.		x	NO		Study of recommended bibliography Problems MAS13, MAS14	1,66	2,5
13	26	More numerical examples on equivalent circuit analysis and scalar speed control.	x		NO		Study of recommended bibliography Solving the rest of numerical examples.	1,66	2,5
14	27	Labo session #3. Starting methods and speed control.		x	NO		Preparation of Labo session #2 report	1,66	2,5
14	28	Second intermediate test.	x		NO			1,66	2,5
							Subtotal 1:	46,5	67,5

							Total 1 *(Horas presenciales y de trabajo del alumno entre las semanas 1-14)*		114	
		Recuperaciones, tutorías, entrega de trabajos, etc								
		Preparación de evaluación y evaluación							3	
								Subtotal 2	3	
							Total 2 *(Horas presenciales y de trabajo del alumno entre las semanas 15-18)*			
TOTAL *(Total 1 + Total 2. Máximo 180 horas)*										