Universidad Carlos III de Madrid
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COURSE: SOLAR ENERGY		
DEGREE: Energy Engineering	**YEAR: 3rd**	**TERM: 2nd**

The course has 29 sessions distributed in 14 weeks. The laboratory sessions are included in these sessions. The students have 2 sessions per week, excepting in one week in which they have 3 sessions.

WEEKLY SCHEDULE

DAY/(WEEK)	SESSION	CONTENTS 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 SCHEDULE FOR STUDENT		
			LECTURES	SEMINARS			DESCRIPTION	IN CLASS HOURS	HOME-WORK HOURS (Max. 7h week)
(1)	1	**Ch. 0. Course Description** **Ch.1 Solar radiation.** The sun. Spectral Distribution of the extraterrestrial radiation. The solar constant. Local and solar time. Definitions: declination, hour, azimuth angle, altitude angle, longitude correction.	X			NO	Course syllabus and basic references. Reading and understanding the notes and basic references. Study and personal work.	1.66	7
(2)	2	**Ch 1. Solar radiation (cont)** Evaluation of the incidence angles (declination, hour, azimuth angle, altitude angle …), and the solar components.		X		NO	Solving the proposed exercises in class. Correction of common errors.	1.66	
(2)	3	**Ch 1. Solar radiation (cont)** Solar resource. Beam and Diffuse components. Radiation on sloped surfaces Clearness index. Estimation of the radiation	X			NO	Reading and studying. Solution of relevant examples.	1.66	7

(3)	4	**Laboratory session-1. Calculation of solar angles, local/solar time using Matlab**		X	COMPUTER ROOM	NO	- Reading of the guideline and instructions documents Participation into the practical session. Preparation of the report: Results analysis and critical evaluation		
(3)	5	**Ch. 2 Radiation Fundamentals.** Fundamentals of radiation. The electromagnetic spectrum. The Blackbody. Plank's and Wien's law. Stefan-Boltzman equations.	X			NO	Reading and understanding the description and deduction of the principal parameters describing the heat transfer by radiation.	1.66	7
(3)	6	**Laboratory session-2. Radiation on inclined surfaces using Matlab**		X	COMPUTER ROOM	NO	- Reading of the guideline and instructions documents Participation into the practical session. Preparation of the report: Results analysis and critical evaluation		
(4)	7	**Ch. 2 Radiation Fundamentals (cont)** Emissive power, irradiation and radiosity. Real surfaces: absorptivity, transmisivity, reflectivity. Snel's law.	X			NO	Reading and understanding the description and deduction of the principal parameters describing the heat transfer by radiation. In-class problem solution. Correction of common errors	1.66	7
(4)	8	**Ch. 2. Radiation Fundamentals (cont)** Kirchoff's Law. Opaque materials. View Factors. Radiation exchange between gray surfaces. Thermal resistance of radiation. Insulators. Shields. Rerradianting surfaces. Surface radiation measurements. Selective surfaces.	X			NO	Reading and understanding the notes and basic references. Study and personal work.	1.66	
(5)	9	**Ch 2. Radiation Fundamentals (cont)** Problems solution using radiation resistances. Applications relevant to solar energy.		x		NO	Solving the proposed exercises in class. Correction of common errors.	1.66	7
(5)	10	**Ch 3. Heat Transfer Fundamentals by convection** Introduction to convection heat transfer. Natural Convection between in external and internal flows: Flat Parallel Plates and between Concentric Cylinders.	X				Reading and studying. Solution of relevant examples. Solving the proposed exercises in class. Correction of common errors.		
(6)	11	**Ch 3. Heat Transfer Fundamentals by convection (cont)** Heat exchagers: collector overall heat loss coefficient		X			Reading and understanding the notes. Study and personal work. Solving the proposed exercises in class. Correction of common errors.		

(6)	12	**Ch 4. Flat-plate collectors** Description. Energy Balance. Temperature distribution. Overall Heat transfer coefficient. Collector performance.	X			NO	Reading and understanding the notes and basic references. Study and personal work.	1.66	
(7)	13	**Ch 4. Flat-plate collectors (cont)** Heat removal factor, F_R and flow factors. Mean fluid and plate temperature. Effective transmittance.		X		NO	Reading and understanding the notes and basic references.	1.66	7
(8)	14	**Ch 6 Evactuate solar Tubes** Description. Energy Balance. Collector performance.		X		NO	Reading and understanding the notes and basic references. Study and personal work.	1.66	
(8)	15	**Ch7. Solar heating. Facilities and storage (cont.)** Solar heating. Facilities: Design of solar heating systems and service water systems. The f-chart method. Liquid-based and air-based solar heating Energy storage. storage tanks. Storage correction.	X			NO	Reading and studying. Deduction of the equation of temperature distribution Study and personal work.	1.66	7
(9)	16	**Ch 7. Solar heating. Facilities (cont.)** F-Chart results. Building heating. Design of a solar facility using Matlab		X	Computer room	NO	Reading and studying. Solution of relevant examples. Voluntary exercises	1.66	
(10)	17	**QUIZ-1.**	X			NO	In-class evaluation activity	1.66	7
/4 (1	19	**Ch. 8. Concentrating solar thermal collectors** Concentration ratio. Parabolic troughs. Fresnel.		X		NO		1.66	
	20	**Ch. 8. Concentrating solar thermal collectors** Central Receivers. **Ch 9. Concentrated Solar Power and other uses of solar thermal energy.** solar hybrid power plants.	X				Reading and understanding of solar applications in industrial processes.		7
	21	**Laboratory session-3. Simulation of a concentrated Solar Power Plant Using SAM**		X	Computer room	NO	Results analysis and critical evaluation. Preparation of the report		
(11)	22	**Ch 6. Concentrating collectors**		X		YES	VISIT TO SOLAR PLANT (9:00- 15:00h)	1.66	

(12)	23	**Ch. 9. Concentrated solar Power: Operation and Maintenance. Hybridation: Concentrating solar thermal collectors**	X			NO	GUEST LECTURE: **Invited Speaker from the Solar Energy Industry** (Sener, COBRA& ACS…)	1.66	7
(13)	24	**Ch 9. Photovoltaic systems.** Photovoltaic effect. Photovoltaic converters. Semiconductors: pn junction. Types of PV technology	X			NO	- Reading and studying: description and deduction of the principal parameters describing the pv technique. Reading of the guideline and instructions documents	1.66	7
(14)	25	**Ch 9. Photovoltaic systems.** Examples and exercises		X		NO	In-class problem solution Presentation of homework results	1.66	
(14)	26	**Ch 9. Photovoltaic systems (cont.)** Related equipment: batteries, inverters, charge controllers, peak-trackers.	X			NO	Reading and study: Simplifying assumptions and methodologies aimed to solve pv engineering problems. In-class problem solution. Presentation of homework results	1.66	7
(15)	27	**Ch 9. Photovoltaic systems (cont.).** Related equipment: batteries, inverters, charge controllers, peak-trackers.		X		NO	In-class problem solution. Presentation of homework results	1.66	
(15)	28	**QUIZ-2**	X			NO	In-class evaluation activity	1.66	7
11	29	**Concentrated solar Power**		X			**VISIT TO SOLAR PLANT**	1.66	
							Subtotal 1	**48.3**	**98**
							Total 1 *(Hours of class plus student homework hours between weeks 1-14)*	146.3	
15		Tutorials, handing in, etc							7
16 17 18		Assessment						3	7
							Subtotal 2	**3**	**14**
							Total 2 *(Hours of class plus student homework hours between weeks 15-18)*	17	
TOTAL *(Total 1 + Total 2. Maximum 180 hours)*								**163.3**	