

Objectives

This international master programme **MSc in Energy Engineering** aims to respond to current energy problems from different perspectives: resources, technologies of production, transport and distribution of energy, environmental impact, efficiency, energy saving and rational use of energy.

MSc in Energy Engineering aims to train experts with the knowledge and skills necessary to analyze case studies and manage projects in power generation, and transformation, distribution and utilization of different energy sources.

Competences and Learning outcomes

Overarching competences

CG1: Integrate and apply mathematical, analytical, scientific, instrumental, technological and management knowledge acquired during university education and be an efficient problem solver within the field of power engineering.

CG2: To size, analyze, design and project equipment, facilities, infrastructures and processes of transformation and transport of energy in any of the phases or stages of the energy chain, from energy resources to energy end use, being able to participate in projects planning, writing, direction and management in the field of power engineering.

CG3: Take part in processes of research, development and innovation in the field of energy technology and energy usage in both, productive and services sectors, providing new insights, technological advances and innovative solutions working in national or international multidisciplinary teams.

CG4: Critically analyze regional, national and supranational energy policies, and know how to apply the energy legislation in any of the fields of energy engineering and energy management.

CG5: Owning the leadership skills and the entrepreneurial spirit necessaries to assume the technical and management direction in public or private organizations in the energy sector.

GC6: Conduct technical advice and technical consultancy in the field of power engineering.

CG7: Analyze the economic, social and environmental impact of technical solutions both in the exploitation of primary energy resources, and in processing, transportation and end use of energy.



Transversal competences

The transversal competences describe what a graduate is able to know or do at the end of the learning process, regardless of the degree. The transversal competences established at UPC are: entrepreneurship and innovation, sustainability and social commitment, knowledge of a third language (preferably English), teamwork and effective use of information resources.

See, for a full description: <u>https://www.upc.edu/ice/innovacio-</u> docent/publicacions ice/arxius/resum competencies postgrau eng.pdf

Specific ILO for the Renewable Energy Specialization:

At the end of the master's degree, graduates will be able to:

- Show a deep understanding of the role of renewable energy in the context of global and regional energy systems, it's economic, social and environmental connotations, as well as the impact of renewable energy technologies on a local and global context; and to make judgments about opportunities, threats and barriers for renewable energy resources and technologies utilization.
- Show a deep knowledge and understanding on relevant organizations, major international projects, the main sources of information, energy markets, and regulatory frameworks related to the utilization of renewable energy resources.
- Efficiently perform the collection and analysis of renewable energy resource data for the design and evaluation of technology solutions related to the use of renewable energy.
- Carry out feasibility studies, consultancy and engineering projects related to the use of renewable energy in productive and services sectors, working in multidisciplinary and international teams.
- Show a good knowledge on the main topics of research and development in the field of renewable energy, be able to provide ideas for the development of innovative new products and services, as well as be prepared for integrating him/herself in research teams and for starting PhD studies in this field.

Courses descriptions

The descriptions of the courses at UPC include, in the Methodology raw, the number of hours the student should devote to the following training activities:

Classroom activities:

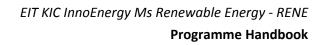
- Lectures and conferences: know, understand and synthesize the knowledge presented by the teacher through lectures.
- Practical sessions: participate in collective decision exercises, as well as in discussions and group dynamics, with the lecturer and other students in the classroom.



- Laboratory: understand the operation of equipment, specifications and documentation; make designs, measurements, verifications, etc.., and present the results orally or by a written report individually or in small groups.
- Presentations: present in the classroom an activity individually or in small groups.
- Tutoring sessions: solving theoretical or practical exercises, individually or in small groups, with the advice of the teacher.

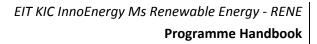
Activities outside the classroom:

- Homework assignments: perform individually or in groups a work or exercise of reduced complexity or scope, applying knowledge and presenting results.
- Project: design, plan and carry out individually or in groups, a project or assignment of wide complexity or scope, by applying and extending knowledge, and writing a report which describes the problem approach and results and conclusions.
- Autonomous study: to study or expand course content individually or in groups, understanding, assimilating, analyzing and synthesizing knowledge.



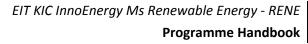


Partner U	niversity	Universitat Politècnica de Catalunya · BarcelonaTech								
Degree		MSc Energy Engineering								
Code	240CF001	Name	Electric	al Engineerin	g fundam	entals				
ECTS	3	Year	1	Semester	1	Character	Basic Skills			
Pre-requis	ites	none								
Prior skills	:	TrigoLinea	onometry ar equati	peration with c / fundamentals on systems with s of Direct Curr	ו complex ו					
Objectives The main objective of this course is providing insights into single- and three-phase electric circuits and electric machines. In order to achieve this objective, the course mainly focution on the theory of the proposed themes together with the resolution of practical exercise. The students determine voltages, currents and powers in electric circuits and analyze the main problems related to energy concerns. Electric machines are also introduced, a synchronous and asynchronous machines are studied and their main applications analyzed.										
Learning outcomes At the end of the course the student will be able to: Solve single-phase circuits in DC and AC steady state. Solve balanced three-phase circuits in AC steady state. Solve single- and three-phase circuits with transformers. Determine voltage, current and powers in DC and AC rotating machines workin steady state. Apply Node Voltage Method for network analysis.										
Course ma	in content	 Thre Elect 	e-phase e-phase tric netwo tric mach	circuits. ork analysis.						
Methodol	ogy	introduce subseque	es the fuently wo	undamental co	ncepts of	the course in t	exercise sessions. The teacher he theory sessions, which are d to the main electric circuit			
Bibliograp	hy:	 J. D. Irwin, R. M. Nelms, "Basic engineering circuit analysis", 8th Edition 2004, John Wiley and Sons, ISBN-10: 0471487287, ISBN-13: 978-0471487289. T. Wildi, "Electrical machines, drives, and power systems", 6th Edition 2005, Prentice Hall, ISBN-10: 0131776916, ISBN-13: 978-0131776913. 								
Student as	sessment	Written exam (midterm exam)25 %Written exam (final exam)75 %								
Contact pe	erson	Luis Sainz	z <u>http://c</u>	lirectori.upc.ed	u/directori	/dadesPersona.js	p?id=1002268			
Link										



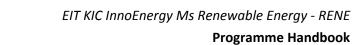


Partner University Universitat Politècnica de Catalunya · BarcelonaTech										
Degree		MSc Energy Engineering								
Code	240CF002	Name	Name Electronics Fundamentals							
ECTS	3	Year	1	Semester	1	Character	Basic Skills			
Pre-requis	requisites none									
Objectives	i	The main objective of this course is to help students to understand the basis of electron devices, both in the analogue domain and the digital domain. In order to achieve the objective, the course mainly focus in practical works where the students analyze, measure and characterize diodes, BJTs transistors, logic gates and operational amplifiers (op-amplembedded in practical examples related to power electronics and control of systems dealine with energy concerns.								
Learning o	utcomes	 At the end of the course the student will be able to: Demonstrate a basic understanding of the electronic devices. Analyze, measure and characterize diodes, BJTs transistors, logic gates and opamps. 								
Course ma	in content	 BJT a Swite CMC 	ching and S digital	Transistors. I amplifier beha	viours.					
Methodol	рду	The course is developed through theoretical learning sessions and practical sessions i electronic and computer labs. In the theoretical sessions, the teacher introduces th fundamental concepts of the course, which is after worked on practical sessions usin application examples related to power electronics and/or simple energy circuits. In th theoretical sessions, the teacher introduces the fundamental concepts of the course, whic are subsequently worked in practical sessions using examples of applications related t power electronics as well as simple circuits related to renewable energy systems.								
Bibliograp	hy:									
Student as	sessment	Theoretic	cal final e	xam and contin	uous evalu	ation of practical	works.			
Contact pe	erson	Rosa Rod	ríguez, <u>h</u>	ttp://directori.u	pc.edu/dir	ectori/dadesPers	ona.jsp?id=1000468			
Link										





Partner University		Universitat Politècnica de Catalunya · BarcelonaTech							
Degree		MSc Energy Engineering							
Code	240CF006	Name	Therm	odynamics Fur	ndamenta	ls			
ECTS	3	Year	1	Semester	1	Character	Basic Skills		
Pre-requis	ites	none							
Objectives The objective of this course is to give students the basis for the understand energy production and storage processes related to the use of renew Fundamental thermodynamics, fluid-mechanics and heat transfer concepts we Elementary processes will be discussed and analyzed using mass and energy b processes will be discussed and optimized on the basis of energy efficiency criteria.						use of renewable resources. Insfer concepts will be reviewed. Ass and energy balances. Global			
Learning outcomes At the end of the course the student will be able to: Pursue an analysis of a power generation system with renewable en thermodynamics and heat transfer principles. 						with renewable energy using			
Course ma	in content	balar 2. Ener 3. CASE 4. Heat 5. Pipe	nces. gy efficie ANALYS transfer flow. Frie	ncy. Use of ther IS: Use of bioma	modynam ass as a noi ptimization nps.	ic cycles in energy n-fossil fuel. n and design crite	c properties. Mass and energy production. ria for heat exchangers.		
Methodology The course is developed through sessions which include both theory and practice teacher introduces the fundamental concepts of the course, but the stude encouraged to further develop these concepts in the analysis of elementary procedure relevant case studies, integrating the most relevant theory concepts, are analyzed.						ourse, but the students are so f elementary processes. Two			
Bibliograp	hy:								
Student as	sessment	Students	are eval	uated through a	final exam	l.			
Contact pe	erson	Xavier Fe	rnández	Francos - Labora	atori de Te	rmodinamica (ETS	SEIB H-building, 8 th floor)		
Link									

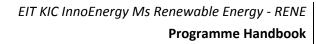


MSc renewable ert energy

Link

Partner University		Universitat Politècnica de Catalunya · BarcelonaTech								
Degree		MSc Energy Engineering								
Code	240CF009	Name	Name Hydraulics Fundamentals							
ECTS	3	Year	ar 1 Semester 1 Character Basic Skills							
Pre-requis	ites	none								
Objectives	3	The main objective of this course is providing insights into fluid mechanics and hydraulic machines. The behaviour of incompressible fluids in motion, the main characteristics and design criteria of free surface flow and pressure flow in pipes, and the main characteristics of hydraulic machines will be introduced and discussed.								
Learning o	At the end of the course the student will be able to: Identify a hydraulic problem. Analyze and evaluate hydraulic situations to solve them by using appropriate too On successful completion of this course, students will have developed a range of ger skills spanning: hydraulic analysis, team work, planning and organization, numerical analyand data analysis.									
Course ma	iin content	OperPipeHydr	omechar n channe hydrauli aulic mo aulic ma	l hydraulics. cs. delling.						
Methodol	ogy	Lectures,	exercise	s, assignments a	nd a visit t	to a hydraulic pov	ver station.			
Bibliograp	hy:									
Student as	ssessment	Final exa	m and co	ntinuous evalua	tion of pra	actical exercises.				
Contact person Eduard Egusquiza <u>http://directori.upc.edu/directori/dadesPersona.jsp?id=1000754</u>										

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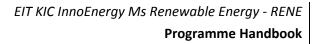




Partner University		Universitat Politècnica de Catalunya · BarcelonaTech								
Degree		MSc Energy Engineering								
Code	820730	Name	Energy	Resources						
ECTS	5	Year	1 Semester 1 Character Mandatory		Mandatory					
Pre-requis	ites	none								
Objectives The main objective of this course is providing insights • The need and importance for energy and its development. • The transformations of energy from its statu energy services ". • The strategic implications for the security of status energy services ". • The strategic implications for the security of security of security of supply, etc. • Work in students the values of justice, solidar						gy and its relat n its status as ecurity of suppl uch as energy	a "energy resource" to its use as" y of different energy sources efficiency, environmental impact			
Learning outcomes The student must understand, describe and analyze in a clear and complete way the e conversion chain; beginning from the "energy source" up until its final use as a "energy service". Identify, describe and analyze the characteristics of the different energy results and the final use of the energy, considering its economical, social and environmentations.							until its final use as a "energetic of the different energy resources			
Course ma	in content	2. 3. 4. Block 2: 1 5. 6.	Basic con The ener Energy st Legal frai Fhe energ Oil. Natural g	cepts. getic problem. ⁻ orage and trans nework. gy sources and i	formation		ns. Actual and future trends.			
Methodolo	ogy	7. Coal. The course is structured in a series of lectures (participatory conferences) to provise transversal items useful for other courses, and an overview of the energy system from different points of view. At the same time students will do several assignments (lectures are exercises). During the course the students will do, in teams of 3 people, a supervised word on a particular energy issue that will en by writing a technical informative article that the will orally present to the supervisor.								
Bibliograp	hy:			the Crossroads. ology, 2003 (and			Jncertainties. Massachusetts ess.			
Student as	sessment	supervise	ed work (30%), activities	made in tl	ne classroom (1	ming activity (40%), the course L0%) and a final exam (20%). Self- I others (20% - 30%).			
Contact pe	erson	Lluis Bate	et <u>http://</u>	directori.upc.ed	lu/director	i/dadesPersona	a.jsp?id=1002339			
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Partner U	niversity	Universitat Politècnica de Catalunya · BarcelonaTech										
Degree	Degree		MSc Energy Engineering									
Code	820731	Name	The po	wer grid syst	em							
ECTS	5	Year	1	Semester	1	Character	Mandato	ry				
Pre-requisites • Thermodynamics fundamentals • Electrical engineering fundamentals												
Objective	5	parti effic • Addr	cular er iencies.	nphasis on it	s fundame	ntal characteri	stics, enviro	of electricity, making nmental impact and and distribution of				
Learning o	outcomes	 At the end of the course the student will be able to: Demonstrate a good knowledge and understanding of the structure of the electrical system; the role of the electrical system in the context of a global energy system; and the systems and technologies involved in the production of electricity, their fundamental characteristics, their efficiency, and their environmental impact. Perform studies on the design, evaluation, selection and implementation of systems for electricity production. Demonstrate a good knowledge and understanding of the most significant aspects of the transmission and distribution of electricity. Demonstrate awareness to the importance of issues such as energy efficiency; environmental impact, security of energy supply. 										
Course ma	ain content	Struc 2. Prod Sche the f plant 3. Tran	uction me and following ts, comb ts); Hydro sport an duction	operation prir technologies: ined cycle pov opower plants d distribution	ciples, effic Thermal p ver plants, s ; Wind pow of electric p	ants (Steam cy olar thermoele er plants; Other ower.	nent and env cle power pla ctric power p s.	ironmental impact of ants, gas cycle power plants, nuclear power ver losses. Maximum				
Methodol	ogy	Lectures, Student v	-	l sessions, exe (hours)	rcises and a	ssignments.						
		Lectures		30	Tutoring se	ssions	15					
		Practical	sessions	15	Homework	assignments	30					
		Laborato	ry	0	Projects		0					
		Presenta	tions	0	Autonomo	is Study	35					
		TOTAL 125										
Bibliograp	hy:											
Student a	ssessment	Exam	70%		Home	work assignmer	nts 30%					
Contact p	erson	Carme Pr	etel <u>http</u>	://directori.up	oc.edu/dired	tori/dadesPerso	ona.jsp?id=1(002326				
Link												

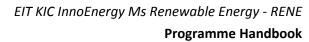




Partner University		Universitat Politècnica de Catalunya · BarcelonaTech									
Degree	Degree		MSc Energy Engineering								
Code	820732	Name	Energy	and Enviror	iment						
ECTS	5	Year	1 Semester 1 Character Mandatory								
Pre-requis	ites	none									
Objectives		 The general objective of the course is to introduce students to the problems associated with energy management and the consequences and effects this has on our environment in terms of pollution with special emphasis on air pollution. The course aims to Identify the effects of energy production and to introduce principles and tools especially those aimed at preventing and minimizing gas emissions. Familiarize students with the tools to predict the behaviour of contaminants using basis models of transport and dispersion and to determine the air quality at a specific point. Introducing the basic knowledge that allows selecting the most appropriate technolog for a treatment according to the type of pollutant, environment, and relevant environmental laws and regulations. 									
Learning o	utcomes	 At the end of the course the student will be able to: Identify the elements of sustainable development and the social, economic and environmental consequences of energy production and utilization. Determine the sources of pollution and the effects on the environment caused by power systems and their environmental impact. Demonstrate a good knowledge and understanding of the tools for emissions assessment with emphasis on carbon footprint. Identify the processes and systems to prevent pollution. Demonstrate a good knowledge and understanding of treatment systems to reduce pollution levels. Identify and assesses the factors that determine the transport and dispersion of atmospheric pollutants. 									
Course ma	in content	 Air P Air P Emis System Gas p Atmost 	ollution. ollution I sion inve ems for tl ourificati ospheric	ntories and c	arbon footpi and control		d dust.				
Methodol	ogy	Lectures, participative sessions, exercices and assignements, including a short project. Student workload (hours) Lectures 18 Practical sessions 6 Homework assignments 35 Laboratory 6 Presentations 0 Autonomous Study 40 TOTAL 125									
Bibliograp	hy	Incer	ntives, Be	ehaviour. Ed.	Elsevier, Am	sterdam.	the Environment: Technology, Isevier, Amsterdam.				



	 Hill, M.K. (2004). Understanding Environmental Pollution. Cambridge University Press, The Edinburgh Building, Cambridge cb2 2ru, UK. Schnelle, K.C., Brown, C.A. (2002). Air pollution control technology handbook. Boca Ratón, Florida: CRC Press. 							
Student assessment	Written test control of knowledge: Work done individually or in groups during the course: Attendance: Quality and performance of group work:	50% 25% 15% 10%						
Contact person	César Valderrama http://directori.upc.edu/directori/dadesPersona.jsp?id=1106028							
Link								





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Partner University		Universitat Politècnica de Catalunya · BarcelonaTech										
Degree		MSc Energy Engineering										
Code	820733	Name	Renev	vable Energ	y Te	echnol	ogy					
ECTS	5	Year	1	Semester	1	L	Characte	er	Mand	atory		
Pre-requis	ites	No specific requisites										
Prior skills• Fundamentals of applied physics.• Fundamentals of Economics• Economic analysis of projects.												
Objectives	i	selectio equipmont of the te	n and s ents and echnolo	sizing of equ d installations	ipm s to hod	ients as a basic s to allo	s well as or pre-provention or pre-provention of the study of the stud	for the	e featu evels. It	ire calo is inter	eded for the descript culations for preexis nded to give an overv ernative assessments	sting view
Learning outcomes At the end of the course the student will be able to: • Demonstrate a good knowledge and understanding of the role of renewable the production and service sectors, as well as its importance in the energy processing, transportation, distribution and end-use and energy efficient and make judgments about opportunities, threats and barriers to their use. • Demonstrate a good knowledge and understanding of the characteristics and k in the sector of renewable energies in Spain and Europe as well as its importate economic productive context. • Critically analyze the policies to promote renewable energy. • Select the most appropriate systems from the point of view of energy for different of applications (industrial or service), and analyze the behaviour of system oper make a diagnosis on your operating system. Course main content 1. Introduction. 8. Geothermal energy. 2. Renewable energy sector. 9. Biomass and wastes.							ce in the energy ch y efficient and is abl ir use. cteristics and key pla Il as its importance in energy for different ty of system operation rgy. stes. els.	nain: le to nyers n an ypes				
Mothodol		5. Sc 6. W 7. M	llar pho ind Ene arine ar	nd hydraulic e	ener	gy.		12. Hy 13. Res	brid sys search	stems.	el cells. velopment.	
Methodol	DRA		-	ipative sessio ad (hours)	ns,	exercic	es and ass	signem	ents.			
		Lectures			30	Tutorir	g sessions			15]	
		Practica		IS	15		vork assign			15]	
		Laborat	ory		0	Project	S			20	4	
		Present	entations 0 Autonomous Study			30	4					
						TOTAL				125		
Bibliograp	hy:	 Joh Wil 	n A. Du [.] ey, 200	ffie, William A 6.	А. В(eckman	"Solar En	ngineeri	ing of T	hermal	n Wiley and Sons, 200 I Processes" 3rd Editi nergy Generation",	



	 Springer, 2005. Thomas Ackermann (Editor), "Wind Power in Power Systems". Wiley, 2005. Simeons, Charles "Hydro-power: the use of water as an alternative source of energy". Pergamon, 1980. Ronald DiPippo; "Geothermal Power Plants (Second Edition)". Edit. Elsevier. 2008. ISBN- 978-0-7506-8620-4. McGowan, Tom "Biomass and alternate fuel systems: an engineering and economic guide". John Wiley & Sons, 2009. R.L. Busby "Hydrogen and Fuel Cells. A comprehensive guide". PennWell Corporation, 2005.
Student assessment	Written exam: 60% Assignments: 40%
Contact person	Josep Bordonau http://directori.upc.edu/directori/dadesPersona.jsp?id=1000079
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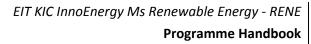
Partner U	Iniversity	Universitat Politècnica de Catalunya · BarcelonaTech									
Degree		MSc Energy Engineering									
Code	820734	Name	Therma	al Equipment							
ECTS	5	Year	1	Semester	2	Character	Mandatory				
Pre-requi	sites	 Completed at least 10 ECTS in Thermal Engineering, including: Fundamentals of thermodynamics. Fundamentals of heat transfer. Fundamentals of fluid mechanics. 									
Prior skill	 Fundamentals of differential and integral calculus Stoichiometry of chemical reactions. 										
Objectives This course focuses on the engineering of heat and cold equipments as well as a exchangers. In this area it is intended that students acquire the knowledge an necessary for the description, selection and sizing, as well as for calculating the perfor of existing equipment and facilities.							quire the knowledge and skills				
 Learning outcomes At the end of the course the student will be able to: Demonstrate a good knowledge and understanding about the role of equipments in the industry and services sectors, as well as their importance energy supply chain. Select the most appropriate thermal equipment from the energy point of view f application (industry or services). Predict the behaviour of existing equipment, perform a diagnosis about its perfor and assess measures for improving its energy efficiency. Design and size -at basic engineering level- thermal equipments used in indust service sectors. 											
Course m	ain content	2. Heat	transfer	equipment. equipment be and AC equipn		luids.					
Methodo	logy	Lectures, participative sessions, exercices and assignements. Student workload (hours) Lectures 30 Tutoring sessions 15 Practical sessions 15 Homework assignments 15 Laboratory 0 Presentations 0 Autonomous Study 30									
Bibliography • Márquez, Manuel. Combustión y quemadores. • Schlünder, Ernst U. [et al.] Heat exchange Hemisphere, 1983. • Rohsenow, Warren M. (ed.) Handbook of h McGraw-Hill, cop. 1998. • American Society of Heating, Refrigerating a handbook. Fundamentals. Atlanta, GA. : ASHRAE • ASHRAE handbook. Refrigeration, Atlanta: American							n handbook. New York [etc.]: nsfer. 3th ed. New York [etc.]: Conditioning Engineers, ASHRAE				



	and, Air-Conditioning Engineers, cop. 2002.							
Student assessment	/ritten exam: 60% Idividual and team curse work. 40%							
Contact person	Enrique Velo http://directori.upc.edu/directori/dadesPersona.jsp?id=1002122							
Link								

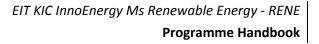


Partner U	niversity	Universitat Politècnica de Catalunya · BarcelonaTech									
Degree		MSc Energy Engineering									
Code	820735	Name	Name Electrical Equipment								
ECTS	5	Year	1	Semester		2	Characte	r	Mandato	νrγ	
Pre-requis	ites	none									
Prior skills			Calculus, complex numbers, differential equations. Basic physics, basic mechanics.								
Objectives	;	This cour	se aims s	students acq	uir	e broad kno	wledge of	f most c	common el	lectrical equipment.	
	 At the end of the course the student will be able to: Demonstrate a good knowledge and understanding on the role of electrical equipm in the production and service sectors, as well as their importance in the energy of processing, transportation, distribution and end-use and energy efficient power. Select the most appropriate electrical equipment from the energy point of view for e application (industry or services). Predict the behaviour of existing equipment, perform a diagnosis about its performa and assess measures for improving its energy efficiency. Design and size -at basic engineering level- electrical equipments used in industry service sectors. Be able to propose improvements in electrical equipment, by developing new ideas 								e in the energy chain: ficient power. point of view for each bout its performance, used in industry and		
Course ma	in content	 Powe Elect Stati 	er transf	anical conve ters							
Methodol	ogy	Lectures, Student v		ative session (hours)	ıs,	exercices an	d assigner	ments.			
		Lectures		1	15	Tutoring ses			15		
		Practical		1	15	Homework a	assignment	S	30		
		Laborato			0	Projects	Church		20		
		Presenta	lions		0	Autonomou	ssiudy		30		
Bibliograp	hy	 TOTAL 125 Ras Oliva, Enrique "Transformadores de potencia, de medida y de protección" 7ª ed. renovada. Barcelona Marcombo, 1988. Sanjurjo Navarro, Rafael "Máquinas eléctricas" Madrid [etc.] McGraw-Hill, 1990. 									
Student as	ssessment	Exam: 70% Assignments: 30%									
Contact pe	erson	Samuel G	Galceran	http://direct	or	i.upc.edu/di	<u>rectori/da</u>	des Per	sona.jsp?id	d=1002930	
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Partner U	niversity	Universitat Politècnica de Catalunya · BarcelonaTech									
Degree		MSc Energy Engineering									
Code	820736	Name	Name Economics and energy markets								
ECTS	5	Year	1	Semester		2	Character		Mandat	ory	
Pre-requisites • Energy Resources • The power grid system											
Prior skills		Basic kno	wledge	on energy s	syste	ems and thei	r operation,	, ecor	iomics ar	nd linear p	programming.
Objectives	This course aims students understanding and being able to apply the concepts relat energy markets.								ots related to		
Learning o	utcomes	 At the end of the course the student will be able to: Demonstrate a good knowledge and understanding on the role of energy managemer in global and regional contexts, and its economical, social and environmental impacts. Demonstrate a good knowledge and understanding on the relevant international organizations, the main sources of information, and those regulations related to the management of energy in different sectors. Carry out activities related to energy management in various sectors, particularly in the energy markets. Propose transferable results - on issues affecting the implementation of the energy management - through the development of innovative ideas. 								al impacts. international elated to the icularly in the	
Course ma	in content			energy mar ation in en							
Methodol	рgy	There wi will be pr	Lectures, participative sessions, exercices and assignements. There will be two assignments to perform during the course by students groups. The work will be presented through a written report. Student workload (hours)								
		Lectures			20	Tutoring ses	sions		15		
		Practical	sessions		10	Homework a	ssignments		15		
		Laborato	ry		0	Projects			25		
		Presenta	tions		0	Autonomous	s Study		40		
						TOTAL			125		
Bibliograp	hy	 D. Kirschen and G. Strbac, Fundamentals of power systems economics, West Sussex, England: John Wiley & Sons, Ltd, 2004. Gómez-Expósito, A., Conejo, A.J. & Cañizares, C., editors, Electric energy systems: Analysis and Operation. CRC Press, Taylor & Francis Group, 2009. 									
Student as	sessment	Exam: Assignme	ents:	60% 40%							
Contact pe	erson	Roberto	Villafáfila	http://dir	ecto	ri.upc.edu/c	lirectori/dad	desPe	rsona.jsp	?id=1065	<u>5131</u>
Link											





Partner L	er University Universitat Politècnica de Catalunya · BarcelonaTech										
Degree		MSc Energy Engineering									
Code	820737	Name	Energy	y efficiency ar	nd ration	al use of ene	ergy				
ECTS	5	Year	1 Semester 2 Character Mandatory								
Pre-requi	isites	none									
Objective	25	options i energy,	nvolvec energy	l in energy eff	ficiency, v ustry, the	with particula	r en	nergy sector and the technological nphasis on the options of storing estate and housing, and existing			
Learning	outcomes	 At the end of the course the student will be able to: Demonstrate a good knowledge and understanding on the role of energy eficiency in global and regional contexts, and its economical, social and environmental impacts. Demonstrate a good knowledge and understanding on the relevant international organizations, the main sources of information, and those regulations related to the energy efficiency in different sectors. Carry out activities related to energy management in various sectors, particularly in energy efficiency related issues. Propose transferable results - on issues affecting the energy efficiency- through the development of innovative ideas. 									
Course m	ain content	 Asser prog Ener, phas Stud Ener, asset Ener, meth lighti Ener, Coge Ener, Coge 	ssment rams fo gy Stora e-chang ies. gy effici so and li- gy effici nodolog ng syste gy effici neratio gy effici	and Energy Aug r promoting en age Techniques ge materials, ch ency in building abilities. ency in building y of energy aug ency in industr n, parameters of ency in transpo	dit: Energ ergy effic : Thermal emical re gs (housin gs (comm lit, Energy kamples. y: Deman of efficien ort: Rail tr	y balance, sam iency. Energy Storag actions, water g sector): Ene ercial and indu cefficiency in I d for electricit cy cogeneration ansport and tr	nple ge us tanl rgy e ustria Elect y an con te ram;	energy, demand management. projects, European and local ing underground structures (UTES) ks, storage of electricity, Case efficiency, solar thermal systems al sectors): Application of the crical Systems, Energy efficiency in d heat to industrial facilities, echnologies. Other modes of transport; Monitoring, Control.			
Methodo	logy	Lectures, companie	-	pative sessions	, exercic	es, assigneme	nts	and visits to energy facilities and			
Bibliogra	phy	 World energy outlook 2011; www.iea.org/weo/ Cibse Guide FEnergy efficiency in buildings Asociación para la Investigación y Diagnosis de la Energía. "Manual de Auditorias Energéticas". Cámara de Madrid. 15 de marzo de 2006. Generalitat de Catalunya. Institut Català d'Energia. "Gestión de la energía en la industria. Programa d'Assessorament Energètic." 6 de mayo 2006. 									
Student a	assessment	Exercises Final exai Lab work	n:	20 % 30 % 20 %							



Link	
Contact person	Jordi Cadafalch http://directori.upc.edu/directori/dadesPersona.jsp?id=1003238
	Monographic work: 30%



Partner U	niversity	Universitat Politècnica de Catalunya · BarcelonaTech								
Degree		MSc Energy Engineering								
Code	240SEL72	Name	Name RENE Project							
ECTS	5	Year 1 Semester 1 Character RENE Specialization								
Pre-requis	ites	none								
Prior skills	;	Engineering projects								
Objectives	ves The overall objective of the 2013 RENE Project is a pre-design and in-depth business feasibility discussion for the innovative energy conversion schemes needed in the respective sub-projects. You shall aim for a "product" that can be brought to the market, and you shap repare your business feasibility discussion such that a business plan can naturally follow a "next step".									
Learning o	putcomes	 After completing the RENE Project, student should be able to: Apply a system approach in analyzing the chain for energy conversion, from primary energy source to energy services. To use the result to carry out an environmental and economical discussion at an advanced level. Develop and explain a need of your product or service. Use basic models for customer, market and competitor analysis. Develop a basic business model. Describe, analyze and develop linkages between technical feasibility and business feasibility. Through project-based working method, be able to take charge and carry out an innovation process concerning problem solving in complex energy conversion chains. 								
 Effectively communicate a project in writing, as well as orally. Course main content The modern society will need to drastically change its view towards a more sustaid behaviour in a global environment. It is today an accepted fact that the increased CO2 atmosphere results in global warming, and that a large part of the drastic increase or over the last 100 years comes from burning of fossil fuels for various energy services us the modern society. When striving towards a sustainable energy system, the concept of heat and presention from renewable energy resources becomes essential. To fully reach the potential of the concept, many innovations are still required. The RENE Project 2013 will be about addressing some specific needs/challenges for chanworking on technically sound engineering designs in combine with a thorough but feasibility discussion of the proposed product/service. Project Teams Teams of students, to form a project group (3-4 per group), should be based on studown interest to address a common challenge. The specific expected outcomes are: 						act that the increased CO2 in the t of the drastic increase of CO2 r various energy services used in e concept of heat and power itial. Nons are still required. The UPC needs/challenges for change by bine with a thorough business				



	 well-investigated concept and background research involving various actors relevant to the task (problem definition – what is needed, engineering approach, critical result analysis, business scenario, etc.) well-analysed concept well-written report communicating the developed concept well performed oral presentation of the concept well displayed presentation (ppt, poster, etc) of the concept A well organized and sufficiently detailed background analysis appropriate for each subproject. A complete background study of "competing concepts" already available or under development. A thorough analysis as the basis for proposing a new concept and pre-design A detailed market analysis including a description of potential customers, an analysis of the market, and a description (based on the background research) of competitors and competing solutions to meet the "need" of your project.
Methodology	During the course students develop an engineering project that is evaluated by the supervisor.
Bibliography	
Student assessment	 Students grading is based on the following deliverables and presentations: Written Report on Project Work Phase I – background, objectives, methodology, principle engineering design and first feasibility results, first business feasibility discussion. 20% 1st Draft Oral presentation and discussion (classroom) WPI Final Report Final report: 80% Oral Final Presentation Final Report
Contact person	Enrique Velo http://directori.upc.edu/directori/dadesPersona.jsp?id=1002122
Link	



Partner L	Iniversity	Universit	at Politècni	ca de Cataluny	a · Barcelona	aTech					
Degree		MSc Energy Engineering									
Code	240SEL48	Name	ame Technological Entrepreneurship								
ECTS	3	Year	1	Semester	1	Character	RENE Specialization				
Pre-requ	sites	Students enrolled in other courses related to Project Management, Ideas Maturation Business Planning. This course works as an accelerator of current activities under work MSc or MBA.									
Previous	skills	Students having innovative ideas.									
Objective	25	This course aims to provide students with an experience-based introduction into the proof starting a technology company. It is a real life simulation of the process that found through when starting a high-tech company.									
Learning	outcomes	 At the end of the course the student will be able to: Develop a creative approach to problem solving. Use basic product creation/development techniques. Demonstrate a good knowledge and understanding on fundamentals related to business and entrepreneurship. Develop presentations, and demonstrate leadership and team-building skills. 									
Course m	ain content	requires participat a student Economic L Managem T T T T Finance: T	students t ion in class in this class ecture: RE ecture: RE ecture: An nent: foolkit: RE & foolkit: RE & foolkit: Stud foolkit: Stud foolkit: Un n foolkit: Busi foolkit: Pivo	o be actively and presentati s (2) & Clean Tech M ergy into Capita entrepreneur in & Clean Tech Ch & Clean Tech Ch & Clean Tech Er dents Team Wo meet Need (den iness Planning v it vs. Iterate inpetition vs. Co	engaged in ion (oral and Market Review lism (Energy n a perfect co nallenges and otrepreneurs wrk in Process mand) and Pro- vs. Validate L operation	the learning proc written) of ideas are w Economics Fundame ompetence world Contests Reviews Meetings Presentations roblem-solving appro earning					
Toolkit: How much money do we need?MethodologyThrough participation in a series of exercises, students have the opportunity to dis expand upon their innate creativity. Basic business concepts from an entre perspective are touched upon "but this class does not cover all of the issues in detail to allow the uninitiated to start their own business" (3).Students are faced with the key issues involved in reviewing technologies, evaluati opportunities, prototyping, designing profitable business models, producing a solid plan, raising capital (FFF, competitions & challenges), addressing legal issues and and gaining first clients.						om an entrepreneurial the issues in sufficient ogies, evaluating market oducing a solid business					



Link	
Contact person	Frederic Horta http://directori.upc.edu/directori/dadesPersona.jsp?id=1049352
	 Grading Guideline: A) Business Competitions go to 100% straightforward. B) Non-competing ideas: Personal Portfolio about 15% Interim presentations 15% Class Participation, Attendance 30% Final report 40%
Student assessment	Note that: "Every entrepreneur faces endless challenges along the way. These problems never have one right answer, and often they have never been solved before. The only way for an entrepreneur to succeed is to view each challenge as an opportunity for a creative solution. The best entrepreneurs seek out challenges. The bigger the challenge, the bigger the opportunity! In this class we will focus on stirring up your creative juices so that you can tackle the challenges ahead" (1).
Bibliography	References:(1) http://e145.stanford.edu/syllabus (2) http://enc.sedtapp.psu.edu/leadership/PDF/407syllabus.pdf (3) http://enc.sauder.ubc.ca/techventure/files/BAEN506_507
	Students gain the skills testing hypothesis and tools to creatively commercialize high tech research or assembling into profitable businesses. Learn to embrace and understand failure rather than fear it. Students meet some entrepreneurs that are some steps forward.



Partner University Universitat Politècnica de Catalunya · BarcelonaTech									
Degree		MSc Ener	rgy Engin	eering					
Code	240SEL44	Name	New Pe	erspectives on	Material	Science and Te	chnology		
ECTS	4	Year	1	Semester	2	Character	RENE Specialization		
Pre-requis	ites	none							
Prior Skills	or Skills								
Objectives The course does not aim to provide specific information necessary for developing new s or to provide a specific skill. In fact the direct objective is to relate some of the pressive scientific knowledge to the main ideas that collaborate to the creation of new materials processes out of them. These are the new perspectives. This is some kind of training with scientific risk. In order that the students can grasp this approach, they will have to do a oral presentations of such packages of ideas and knowledge that may lead to a new materials, applications and industrial products. In this sense, students' work concentration on preparing projects and defending them. Within this context, it is interesting to highly their final assessment, titled "High Value Opportunities for Materials and Process: Innovation as related to Energy Issues ", where students (working as 5/6 people te debate and choose the best materials-related option for investing 10M€ donated by chairperson of a successful large company to R&D institutions represented by the reference teams. Attempting to narrow the window of technologies to be propelled from researe laboratory into application scale, several high priority innovation areas are identified by Course's mentor: Wave / Wind power; Solar power; Biomass / Biofuels; Hydrog generation; Hydrogen distribution and storage; Nuclear power; Thermoelectric materials and Fuel cells.							to relate some of the present e creation of new materials and is some kind of training with the bach, they will have to do a few that may lead to a new material se, students' work concentrates ext, it is interesting to highlight for Materials and Processing (working as 5/6 people team) nvesting 10M€ donated by the ons represented by the referred to be propelled from research ation areas are identified by the Biomass / Biofuels; Hydrogen ower; Thermoelectric materials;		
Learning o	outcomes								
Course ma	iin content	ma crys coll 2. Cha Sm	vision to tter: ord stalline s loidal sol allenges art Mate	er and disorder olids. Between utions. and perspective	The perfe order and es: Photon	ect gas. Crystals. disorder. Compo ic Materials. Mat	Basic elements. Two states of Crystalline solids. Liquids. Non- site materials, suspensions and terials for Information Storage. Polymers. Surfaces, Interfaces		
		Invited Speakers: This part of the course consists in attending specific talks, given by specialists and experts in the different fields of interest of the course that will present relevant aspects related to the different materials and their characterization. These talks are meant to provide a deepe insight into particular aspects of the challenging areas that are presented in the lectures.							
Methodol	ogy	Course is distributed on three well-defined activities: Introduction and brief review of Materials Science and Technology (review lectures by Course's responsible) – 25%; Invited seminars by specialized speakers – 45%; Oral presentations by students – 30%. All the activities will take place in a conventional lecture room. Both the lectures and the invited talks will take place in a conventional way in a lecture room. The presentations are meant to include discussion and the students will be asked to participate in it. The invited lectures will be more formal and it is expected that discussion with every speaker will take							



	place after the presentation. This is a great opportunity for the students to grasp aspects such as development and innovation in the field of Materials Science and Technology.
	The practical aspect of the course looks for the work in group of the students around the preparation of a subject, the writing of a report and its presentation and defence. In fact what is being looked for is their ability to choose and defend a new technology and its application in industry, including the economical, social and environmental assessment.
Bibliography	
Student assessment	The students will be evaluated by means of a written exam, the report that they will write and the evaluation of their public presentation.
Contact person	Luis Llanes http://directori.upc.edu/directori/dadesPersona.jsp?id=1002332
Link	



Partner U	niversity	Universitat Politècnica de Catalunya · BarcelonaTech								
Degree		MSc Ener	rgy Engin	eering						
Code	240SEL057	Name	Oral ar	nd written con	nmunicati	on				
ECTS	3	Year	1	Semester	2	Character	RENE Specialization *			
Pre-requis	ites	none								
Prior Skills	Prior Skills English level: B2									
Objectives	5	written c	ommuni	cation and to e	nable then	n to write docum	ics and peculiarities of technical ents of different academic and n writing in an efficient way.			
 At the end of the course the student will be able to: Recognize and distinguish different/ common aspects in technical documents that an addressed to different audiences and written for different purposes (such aspects a tone, style, level of detail and level of technicality in terminology, etc); Organize, structure and develop information according to the most usual patterns of information organisation in scientific and technical discourse; use connectine expressions that make documents coherent and write documents that are proper punctuated, grammatically correct, and stylistically appropriate; Write Curriculum Vitae, different formal letters, and reports; Apply the general guidelines on technical written communication and be able to autonomously continue with their learning by means of several electronic resources. 										
Course ma	in content	1. Part II. Th 2. 3. 4. PART III.	What is t ne Writin Pre-writi Writing s Post-writ Documer	stage ting stage	-					
 Methodology The course focuses on speaking and writing skills and activities are an integral part of course, including delivering an oral presentation (product –process description), attem meetings, and memo and report writing. Preparation for these activities will rebecoming familiar with different degrees of style (formal-informal) and tone, revising a grammatical aspects or practising vocabulary related to meetings (e.g. agreeing-disagree for example. Students will also carry out some teamwork tasks. The course will be to upon a combination of the following three methodologies: Practical lessons where the teacher starts explaining different aspects and then stude osome practice tasks and solve communication problems (Problem-Solving appro Individually or in pairs students carry out tasks to practise the aspects covered in module. Case Method: reading a case. Students solve communicative problems arising from case. Different situations will require different types of communication. 						process description), attending r these activities will require ormal) and tone, revising some ings (e.g. agreeing-disagreeing), asks. The course will be based erent aspects and then students ns (Problem-Solving approach). se the aspects covered in every ative problems arising from the				
Bibliograp	hy									
Student as	ssessment	•	Individual Work 90% Work done in the classroom: 5% Test 1: 15%							

Universitat Politècnica de Catalunya, UPC BarcelonaTech, Spain | KTH Kungliga Tekniska Högskolan, Sweden IST Instituto Superior Técnico, Portugal | École Polytechnique, ParisTech, France | ESADE Business School, Spain TOTAL, France | EDF, France



	 Test 2: Final exam: Working Group: Project: 	15% 55% 10% 10%
Contact person	Marta Aguilar - <u>http://directo</u>	ri.upc.edu/directori/dadesPersona.jsp?id=1000637
Link		

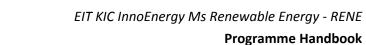
*Mandatory except for students from USA, Canada, UK, Ireland, Australia or New Zealand.



Partner U	niversity	Universit	at Politè	cnica de C	Catalı	unya - Barce	elonaTech				
Degree		MSc Rene	MSc Renewable Energy								
Code	820739	Name	Name Wind Power								
ECTS	5	Year	2	Semeste	r	1	Character	Ele	ective		
Pre-requis	ites	Basic Eleo	ctrical an	d Mechan	ical E	ngineering.	Electrical Cir	cuit Ana	lysis		
Objectives	3	analyze	wind po	wer gene	ratio	n systems.	-	course		d to understand and y state and dynamic	
Learning o	outcomes	•	Understa Determir Analyze t Understa	and the prine the steat the dynamic how w	incipl ady st nic be vind t	tate condition haviour of w urbines can	ical generatio	n wind p ed in wir	ower g nd pow	generation system	
Course ma	ain content	 The v Princ Fix-sp Varia 	vind resc iples and beed win ble spee	l compone d turbines d wind tur	labor ents c 5 PC bine	laboratory.	ines PC labo Activity 2. atory. Activity	-	Activit	у 1	
Methodol	ogy	Theory cl Student v		-			assignment 1	to be de	velope	ed at home.	
		Lectures									
		Practical Laborato			12 5	Homework assignments15Projects10					
		Presentat			0				55		
						TOTAL			125		
					-						
		ActivityDescription1. Power curve and energy extractionFor a given location and known wind resource information, and considering a given wind turbine with known power curve, the activity will develop an energy extraction analysis also considering the influence or different parameters.							wind turbine with a develop an energy		
		2. Steady-state and dynamic analysis of a fix-speed wind turbineA given fix-speed wind turbine will be analyzed in steady-state and with dynamic simulations.									
		analysis	3. Steady-state and dynamic analysis of a variable speed wind turbineA given variable speed wind turbine will be analyzed in steady-state and with dynamic simulations.								
		4. Wind plannin	power p g	lant		-	ed planning be conducte	-	n offs	hore wind power	
Bibliograp	hy	• Wir	nd Turbi	ne Opera	tion	in Electric	Power Syste	ms: Adv	/anced	Modeling, Zbigniew	



	 Lubosny, Springer Verlag, 2003. Wind Power in Power Systems, Thomas Ackermann (Editor), Wiley, 2005. Wind Turbine Control Systems: Principles, Modelling and Gain Scheduling Design, Bianchi et al., Springer 2007. Wind Turbines, E. Hau, Springer 2006. Wind energy generation: Modelling and Control, O. Anaya-Lara, N. Jenkins, Ekanayake, P. Cartwright, M. Hughes, John Wiley and Sons, 2009. Embedded Generation, N. Jenkins, R. Allan, P. Crossley, D. Kirschen and G. Strbac., Th Institution of Electrical Engineers, 2000. 					
Student assessment	Written exam (final exam) Activity 1:	50% 10%				
	Activity 2:	10%				
	Activity 3:	10%				
	Activity 4:	10%				
	Oral presentation	10%				
Contact person	Oriol Gomis <u>http://directori</u>	.upc.edu/directori/dadesPersona.jsp?id=1004465				
Link						



MSc renewable eit energy

Programme Handbook

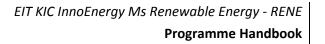
Partner U	niversity	Universit	Universitat Politècnica de Catalunya - BarcelonaTech							
Degree		MSc Ene	rgy Engir	eering						
Code	820740	Name	ame Solar Photovoltaics							
ECTS	5	Year	2	Semester	1	Character	Elective			
Pre-requi	sites	none								
Previous	kills	Electrical	Enginee	ring Fundamer	ntals					
Objective	5	photovol converte and desig	ltaic tecl rs, energ gn are co	hnology The ogy storage, cha onsidered. Som	different sy rge controll e of the two	stem componer er, loads, etc.) a o most importan	y of electricity generated using nts (modules or panels, power and some aspects of the analysis t applications using solar energy:			
Learning	outcomes	 Dem cont impa Dem radia Dem char Dem proje relat Dem solai proce Anal dem Carri phot Dem 	 context of regional and global energy systems, it's economic, social and environmental impacts, as well as the impact of technology on a local and global context. Demonstrate a good knowledge and understanding on the basic concepts of solar radiation, the electrical principles and main parameters of PV device. Demonstrate a good knowledge and understanding on the most important characteristics of the elements within a PV system besides panels: battery, battery charge controller, DC/DC converter, D C/AC converter (inverter) and loads. Demonstrate a good knowledge and understanding on relevant organizations, the main projects in the international field, the main sources of information and the regulations related to solar photovoltaic technology. Demonstrate a good knowledge and understanding on some practical applications using solar PV systems: analyze, design (sizing) of a stand-alone PV system and the energy produced by a Grid-Connected Photovoltaic Systems (GCPVS). Analyze the behavior of a system for energy self-consumption and production with demand-side management and grid metering. 							
Course m	ain content	 Introduction to Solar Photovoltaic Energy Solar Radiation Photovoltaic Systems Analysis, sizing and maintenance of a photovoltaic system 								
Methodo	ogy	Lectures, participative sessions, exercices, assignements and lab sessions. Student workload (hours) Lectures 32 Tutoring sessions 15 Practical sessions 15 Homework assignments 20 Laboratory 0 Presentations 0 Autonomous Study 13 TOTAL 125								



Bibliography	Deutsche Gesellschaft filr sonnenenergie, Planning & Installing Photovoltaic Systems, A guide for installers, architects and engineers: First published by Earthscan in the UK and USA in 2008, First edition published in 2005, reprinted 2006, Copyright © The German Energy Society (Deutsche Gesellshaft fur Sonnenenergie (DGS LV Berlin BRB), 2008.							
Student assessment	Written exam60%Class and lab Work35%Attendance5%							
Contact person	Rafael Martin Lamaison http://directori.upc.edu/directori/dadesPersona.jsp?id=1002064							
Link								



Partner U	niversity	Universit	at Politè	cnica de Ca	tal	unya - BarcelonaTec	:h			
Degree		MSc Ren	ewable E	nergy						
Code	820743	Name Photovoltaic Devices								
ECTS	5	Year	2	Semester		1 Charact	ter	Elective		
Pre-requis	ites	Solar photovoltaics								
Prior Skills	;	Basic kno	wledge o	on power el	ect	ronics.				
Objective	;	cover fro	m conve	ntional crys	tal			aic solar cells. Course conter echnologies. Advanced concer		
Learning o	outcomes	At the en	d of the o	course the s	tu	dent will be able to:				
		solar • Dem phot • Prop	r cells, fro onstrate ovoltaic o ose alter	om the most a good conversion.	t ba kn	osic aspects of semic pwledge and unde	onductor erstandin	n the operation of photovolta r device to the final finish. ng on advanced concepts he manufacture of photovolta	in	
Course ma	iin content	 Pro PN Cry Thi Solution 	Junctions stalline son film sol	of sunlight s and solar o olar cells lar cells aracterizatio	on	operation taic conversion.				
Methodol	ogy		-		ıs,	exercises, assignmer	nts, and p	presentations.		
			workload (20	T				
		Lectures Practical	cossions		30 20	Tutoring sessions	otc	5 35		
		Laborato		· · · ·	20	Homework assignmer Projects				
		Presenta			5	Autonomous Study		30		
					-	TOTAL		125		
Bibliograp	hy	 Green, M.A. Solar cells: operating principles, technology and system applications. Prentice Hall, 1981. ISBN 0138222703. Markvart, T.; Castañer, L. (eds.). Practical handbook photovoltaics: fundamentals and applications. Oxford: Elsevier, 2003. ISBN 1856173909. 								
Student as	ssessment	Exam50%Work done individually or in groups during the course40%Attendance and participation in classes and laboratories5%Quality and performance of the work group5%								
Contact p	erson	Joaquim	Puigdolle	ers <u>http://di</u>	rec	tori.upc.edu/directo	ori/dades	Persona.jsp?id=1002739		
Link										

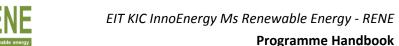




Partner U	niversity	Universitat Politècnica de Catalunya - BarcelonaTech							
Degree		MSc Rene	ewable E	nergy					
Code	820744	Name	Name Solar Thermal Energy						
ECTS	5	Year 2 Semester 1 Character Elective							
Pre-requis	ites	none							
Prior skills		-	-				odynamics, fluid mechanics and hermal systems.		
Objective	;	 Introduce the heat transfer phenomena present in solar thermal systems and equipment. Study the materials used in solar thermal applications such as selective treatments, accumulating materials for phase change, transparent insulating surfaces, etc Study the different methodologies that allow the design and calculation of solar thermal systems and equipment. Performing different practical work for testing solar collectors and solar thermal systems to heat-UPC CTTC. Study different applications of solar energy. 							
Learning o	utcomes	 Dem conti impa Dem radia Dem proje relat Carry theri Dem theri 	onstrate ext of re acts, as w onstrate onstrate ects in th ed to sol y out a mal techn onstrate mal techn	gional and globa rell as the impac a good knowl e principles and a a good knowled he international ar thermal techn project, at basi nology. a good knowled nologies and be	dge and u al energy s t of techno edge and main parar dge and ur field, the u nology. c engineer dge and un able to pro	nderstanding on systems, it's ecor- ology on a local a understanding on neters of solar th oderstanding on main sources of ring scale, relate derstanding on a opose-transferab	the role of solar energy in the nomic, social and environmental nd global context. on the basic concepts of solar nermal devices. relevant organizations, the main information and the regulations ed to energy supply using solar dvanced concepts in solar le results in implementing solar		
Course ma	in content	 avail Mate surfa Low, of op field. Ther strat ener Low, ener 	thermal technologies by developing new ideas. Introduction. Basics of solar radiation and solar energy availability. Estimation of the available solar radiation. Materials used in the feedback systems. Opaque and transparent surfaces. Selective surfaces and transparent insulation materials. Low, medium and high temperature solar thermal systems (solar collectors). Principles of operation. Study of the mechanisms of heat transfer. Performance of the collecting field. Testing of a solar collector. Thermal energy storage systems for low, medium and high temperature. Thermal stratification and its influence on the performance of an installation. Testing thermal energy storage systems. Modeling of thermal storage systems. Low, medium and high temperature facilities. Solar thermal plants. Applications of solar energy: i) domestic and industrial systems for hot water and heating; ii) solar thermal installations. Dimensioning and simulation of Solar thermal facilities.						
Methodol	ogy	Lectures,	participa	ative sessions, e	xercices, as	ssignements and	lab sessions.		



	Student workload (hours)					
	Lectures	15	Tutoring sessions	15		
	Practical sessions	15	Homework assignments	30		
	Laboratory	0	Projects	20		
	Presentations	0	Autonomous Study	30		
			TOTAL	125		
Bibliography	 3rd Edition edition (8 Soteris A. Kalogirou. S Ed. 2009. G.N. Tiwari, Solar Ener W. Vogel and H. Kalb. kGaA., 2011. G.Alefeld, R.Radermad 	Sep : olar rgy: 1 . Lar cher,	, Solar Engineering of Therm 2006) Energy Engineering: Process technology advances. Nova S ge-scale solar thermal powe Heat Conversion Systems, C ther, S.A. Klein. Absorption	ses and Sy Science Pu er. Wiley-\ CRC Press,	vstems. Academic Press Iblishers, Inc. 2006. /CH Verlag GmbH& Co. Boca Raton, 1994.	
Student assessment	Exam50%Work done individually or in groups during the course40%Attendance and participation in classes and laboratories5%Quality and performance of the work group5%					
Contact person	Ivette Rodríguez <u>http://dire</u>	ctor	.upc.edu/directori/dadesPe	rsona.jsp?	'id=1004330	
Link						



Programme Handbook

Partner U	niversity	Universit	at Politècnica de C	Catal	unya - Barcel	onaTech				
Degree		MSc Enei	gy Engineering							
Code	820747	Name	Integration of R	ntegration of Renewable Energy Systems to the Grid						
ECTS	5	Year	2 Semeste	r	1	Character	Elective			
Pre-requis	ites	none								
Prior skills		Basic Electric and Mechanical Engineering Electrical Circuit Analysis								
Objectives		analyze t include c • Anal • Grid • Grid • Isola • HVD • The	 Grid integration of renewable systems. Smart grids Grid codes Isolated and connected Microgrids HVDC Supergrids for offshore wind 							
Learning o	utcomes	 Dem rene Anal Dem effici Dem relev Anal 	wable energy syste yze power systems onstrate a good ki ently integrated in	nowle ems with nowl pov nowl e ene	edge and und n a high pene edge and und ver systems ledge and und ergies in it ids	erstanding on h tration of renev derstanding on derstanding on	vables how renev	systems interact with wable energies can be grid concept and the		
Course ma	in content	 Anal Grid Supe 	duction ysis of power syste support ergrids ogrids	ems v	with renewab	le energy				
Methodol	ogy	Theory classes, Simulation practices, Project assignment to be developed at home. Student workload (hours) Lectures 6 Practical sessions 15 Practical sessions 20 Laboratory 4 Projects 30 Presentations 0 Activity Description								
		Activity 1. Grid s	upport		Description Simulations of	n grid support fro	om renewah	ples will be performed.		



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	2. Supergrids analysis Project	A given power system of a Supergrid will be analyzed using standard tools for power system power flow analysis. Several offshore wind power plants will be included and analyzed. After discussion with the instructor, a project will be assigned and developed by the students with appropriate tutoring.
		and developed by the students with appropriate tutoring.
Bibliography	 Embedded Generation, N Institution of Electrical Engi Wind Turbine Operation Lubosny, Springer Verlag, 20 Wind Power in Power Syste Wind energy generation: M P. Cartwright, M. Hughes, Jo 	in Electric Power Systems: Advanced Modeling, Zbigniew 203 ms, Thomas Ackermann (Editor), Wiley, 2005 odelling and Control, O. Anaya-Lara, N. Jenkins, J. Ekanayake, ohn Wiley and Sons, 2009 oltaic and Wind Power Systems, R. Teodorescu, M. Liserre, P.
Student assessment	Written exam50%Activity 115%Activity 215%	
	Project 20%	
Contact person	Oriol Gomis- <u>http://directori.upc</u>	.edu/directori/dadesPersona.jsp?id=1004465
Link		



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Partner U	niversity	Universit	at Politèc	nica de Ca	talı	unya - Barcel	lonaTech			
Degree		MSc Ene	MSc Energy Engineering							
Code	820748	Name	Name Hydrogen and Fuel Cells							
ECTS	5	Year	2	Semester		1	Character	•	Elective	
Pre-requis	ites					·				
Prior Skills	;	Basic kno	wledge ir	n chemistry	/ an	d physics				
Objectives	;	This cour	se aims to):						
Learning o	outcomes	whic trans Prov obta impl Prov insta Insti hydr At the en	 which involves a fuel cell from chemical data, biological catalysis, materials, heat transfer and flow of matter and energy. Provide students the skills to analyze any kind of scientific and technological method of obtaining and handling hydrogen for use in fuel cells and express rules for its implementation, optimization and / or modification. Provide students the skills to identify the problems and deficiencies of energy installations and electrical devices and be able to provide engineering solutions. Instil in students the cientific spirit to investigate new developments in the field of hydrogen and fuel cell vector. 							
		conr Dem curre and Dem fuel (elec Perfe	onstrate a onstrate a ent project different t onstrate a cells in s cronic dev	and impact a good kno cts and fut cypes of fue a good kno tationary o vices). Isic scale	: ec owle ure el c owle env	onomic, soci edge and und challenges ells. edge and und ironments (l	al and env derstandin related to derstandin buildings),	ironmo ng on tl the pr ng on th mobil	ental. he main s rocesses he applica le (transp	system as well as its sources of information, of obtaining hydrogen ations of hydrogen and portation) and laptops system for producing
Course ma	in content	-	age and tr	duction teo ansport of		-				
Methodol	ogy				ns,	exercices, an	d assigner	ments.		
			workload (I		45	T			4.5	
		Lectures Practical	sessions		15 15	Tutoring sess Homework a			15 0	
		Laborato			0	Projects	555111101115	<u> </u>	50	
		Presentations 0 Autonomous Study 30								
					-	TOTAL	, ,		125	
Bibliograp	hy	 R.L. CLEF 	Busby "Hy S CEA nº S	/drogen an 50/51 "L'hy	d Fi ydro	ogène, les no	omprehen ouvelles te	isive gu chnolo	uide". Pen ogies de l'o). nWell, 2005. énergie", 2004. Prospects for a Cleaner



	Planet". MIT Press, 2001.
Student assessment	Exam 50% Assignments 50%
Contact person	Jordi Llorca http://directori.upc.edu/directori/dadesPersona.jsp?id=1049344
Link	



Partner University		Universitat Politècnica de Catalunya - BarcelonaTech										
Degree	Degree		MSc Energy Engineering									
Code	820750	Name	Power Electronics applied to distributed Energy Resources									
ECTS	5	Year	2	Semester	1		Character	Elective	2			
Pre-requis	ites	none										
Prior Skills	;											
Objectives		This course aims to examine the techniques of power electronics and control systems based on microprocessors. These techniques focus on speed and torque control of electrical machines, as well as in the control of power flow in an electrical grid.										
Learning outcomes		 At the end of the course the student will be able to: Modelling and simulating a static converter. Designing and using a commercial converter. Apply a converter to the DER (Distributed Energy Resources). Apply a converter against the grid (Active Front Ends and FACTS). 										
Course ma	in content	 Fundamentals of static converters Generation of sinusoidal waves (PWM) Intensity loops: constant frequency, quasi constant and variable Applications: solar and wind converters, and active filters 										
Methodol	ogy	Lectures, participative sessions, exercices, and assignements. Student workload (hours)										
		Lectures 20 Tutoring sessions 15										
							30					
		Laborato	ry	0	Proj	ects		20				
		Presentat	tions	0	Auto	nomou	s Study	30				
					TOT	AL		125				
Bibliograp	hy	 Mohan, N., Undeland, T., Robbins, WP., Power Electronics: Converters, Applications a Design. John Wiley & Sons Inc., New York, 1989. ISBN 0471580488 Philip T. Krein, Elements of Power Electronics. Oxford University Press, Copyri, September 1997, ISBN13: 9780195117011 ISBN10: 0195117018 										
Student as	sessment	Exam 50% Assignments 50%										
Contact person Joan Bergas <u>http://directori.upc.edu/directori/dadesPersona.jsp?id=1002</u>							p?id=1002645					
Link												



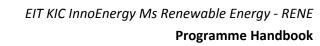
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Partner University		Universitat Politècnica de Catalunya – BarcelonaTech										
Degree		MSc Renewable Energy										
Code	820755	Name Smart Grids										
ECTS	5	Year 2 Semester 1 Character Elective										
Pre-requis	ites											
Prior Skills	5	Electrical	enginee	ring fundame	entals	5						
Objective	5	This courses aims to introduce students to smart grids and to the utilization of tools for calculating basic grids: nodal analysis and load flow.										
Learning outcomes At the end of the course the student will be able to: • Analyze grids in steady state by using the MNA method (Modified Nodal Analyze grids in steady state by using the load flow method. • Analyze and use the common electro optimization mechanisms: regulation active and reactive power flows. • Choose and implement mechanisms for managing grid energy flow.												
Course ma	ain content			transmission echnical Syste		stributior	n systems					
Methodol	ogy	Lectures, participative sessions, exercices, and assignements. Student workload (hours)										
		Lectures			20	Tutoring	g sessions					
		Practical	sessions		10	Homewo	ork assignments	65				
		Laborato	ry		0	Projects		0				
		Presenta	tions		0	Autonon	nous Study	30				
						TOTAL		125				
Bibliograp	hy	 Zhang, Xiao-Ping Flexible AC transmission systems: modelling and control Springer 2006. Arthur R. Bergen Power systems analysis Prentice-Hall 2000. Narain G. Hingorani, Laszlo Gyugyi Understanding facts: concepts and technology of flexible AC transmission systems IEEE Press 2000. 										
Student a	ssessment	Exam50%Assignments50%										
Contact p	erson	Joan Rull	http://d	irectori.upc.e	edu/d	lirectori/	dadesPersona.jsp	?id=100043	1			
Link												



Partner University		Universitat Politècnica de Catalunya - BarcelonaTech									
Degree		MSc Energy Engineering									
Code	820757	Name	Compu	tational N	Netho	ds in Ene	ergy Techno	logy	,		
ECTS	5	Year	2	Semester	1		Character		Elective		
Pre-requis	ites										
Prior Skills	;	A good knowledge on fluid dynamics and heat and mass transfer, as well programming skills.									
Objectives	;	This course aims students:									
		 Acquiring a basic training in solving numerically the governing equations of fluid dynamics and heat and mass transfer phenomena. Acquiring a first practical experience in programming, verification and validation of CFD codes & HT (Computational Fluid Dynamics and Heat Transfer). Become familiar with the use of CFD codes & HT and acquire the ability to judge critically the quality (verification and validation of numerical solutions of mathematical formulations used). 									
 Learning outcomes At the end of the course the student will be able to: Consolidate the basic mathematical formulations of fluid dynam heat and mass transfer. Demonstrate a good knowledge and understanding on different m integration of the Navier-Stokes equations. Apply RANS, LES and DNS methods to the resolution of turbulent flo Apply code verification techniques, and verification and valida numerical solutions of mathematical formulations. 						lifferent me rbulent flov	ethods of nume	erical			
Course ma	in content	 Introduction to numerical methods used in fluid dynamics and heat and mass transfer phenomena. Solving the conduction heat transfer equation in irregular domains. Permanent and transient analysis. Solving convection-diffusion type equations. Techniques for codes verification and numerical solution verification and review of thmost appropriate solvers. Solving the Navier-Stokes equation. 								and	
Methodol	ogy				ons, exe	rcices, a	nd assigneme	ents.			
		Student v	vorkload	(hours)		Tuto					
		Lectures Practical	sessions		15 15	0	sessions ork assignment	.c	12 20		
		Laborato			3	Projects	and a solignment		30		
		Presentat	,		0		nous Study		30		
		TOTAL 125									
Bibliograp	hy	 Incropera, F. P.; DeWitt, D. P. Fundamentos de transferencia de calor. 4ª ed. México: Prentice Hall, 1999 Eckert, E. R. G.; Drake, R. M. Heat and mass transfer. 2nd ed. New York: McGraw-Hill, 1959. Patankar, S. V. Numerical heat transfer and fluid flow. New York: McGraw-Hill, 1980. J.H.Ferziger, M.Peric, Computational Methods for Fluid Dynamics, Springer, 2001 (3r 									

	 Pearson Prentice Hall, 1995 John D. Anderson, Jr, Computational Fluid Patrick J. Roache, Fundamentals of Compu- 1998. 	utational Fluid Dynamics, Hermosa Publishers, ynamics for engineers: from panel to Navier-
Student assessment	Exam Assignments:	30% 60%
	Attendance: Quality and performance of the team work	5% 5%
Contact norsen		
Contact person	Oriol Lehmkuhl Barba <u>http://directori.upc.edu</u>	/unecton/dadesPersona.jsp?ld=1078527
Link		





Partner University		Universitat Politècnica de Catalunya - BarcelonaTech									
Degree		MSc Renewable Energy									
Code	820763	Name	Name Thermal and Thermochemical Energy Storage								
ECTS	5	Year	2	Semester	1	Character	Elective				
Pre-requis	ites	none									
Prior Skills		The gene	eral aspec	ts of thermody	namics, flu	id mechanics and	heat and mass transfer.				
Objectives		The course aims to describe the new energy paradigm of distributed generation, where the thermal/thermochemical energy storage plays an important role in decoupling power generation and energy consumption. The course also aims to give a detailed description of most of the technologies that are used in thermal and thermochemical energy storage such as thermal energy storage tanks for sensitive and/or latent heat, fuel cells and adsorption and absorption refrigeration systems.									
Learning outcomes At the end of the course the student will be able to: • Demonstrate a good knowledge and understanding on systems and technologies. • Demonstrate a good knowledge and understanding on environmental issues. • Demonstrate a good knowledge and understanding on materials use thermochemical and thermal energy storage equipment. • Demonstrate a good knowledge and understanding on issues related to the or evaluation, selection and implementation of chemical and thermal storage system • Demonstrate a good knowledge and understanding on fuel cells, types of cells a technological development. • Demonstrate a good knowledge and understanding on fuel cells, types of cells a technological development.											
 Course main content Energetic audits: energy, Exergy and other performance indicators. U accumulation of energy and heat pumps. Distributed energy generation al systems: co-generation, thermal cycles and cold and hot networks. Accumulation of thermal energy by sensitive heat. Active and passive syst ways for accumulation. Importance of thermal stratification. Strategies to thermal stratification of thermal stratification. Strategies to thermal stratification of thermal energy by latent heat. Selection of materials of pha according to the application. Typology of the systems of accumulation by pha Modelling of phase change systems. Accumulation systems in solar-thermal plants. Importance of energy accum solar-thermal plants. Typology of main utilized systems. Main storage advantages and disadvantages. Integration of the accumulation system Accumulation of thermochemical energy. Operation principles. Reactive Applications: energy storage in buildings, cooling by absorption. Actual deverge thermological aspects. Accumulation of thermochemical energy. Fuel cells: theoretical function of persition and thermochemical energy. Fuel cells: theoretical function of persitional fuel batteries. Technological development of different types of ba 7. Hydrogen as energetic vector. Gathering and storage of hydrogen. 						energy generation and storage networks. tive and passive systems. Main fication. Strategies to intensify ation: methods based on energy em. on of materials of phase change accumulation by phase change. nce of energy accumulation in stems. Main storage means: umulation system in the solar- principles. Reactive couples. sorption. Actual developments. Ils: theoretical fundamentals. f different types of batteries.					
Methodol	ogy	Lectures,	participa	ative sessions, e	xercices, a	nd assignements.					



	Student workload (hours)								
	Lectures	ctures 20 Tutoring sessions		5					
	Practical sessions	20	Homework assignments	15					
	Laboratory	5	Projects	30					
	Presentations	0	Autonomous Study	30					
			TOTAL	125					
Bibliography	 D.Y. Goswami and F. Kreit Eastop, T. D. and Croft, D. Winter, C. J., Sizmann, R. I <i>Thermal Energy Storage</i> Wiley & Sons, UK, 2002. Herold, K. E., Radermach 1996. W. Vielstich. Cèlulas de Comparison 	h, Energy R., Energy and Va Systems er, R. ar ombustió	Ianagement Handbook, 7th ec y Conversion, CRC Press, 2007. gy Efficiency for Engineers and ant-Hull, L. L., Solar Power Plan and Applications, edited by nd Klein, S. A. Absorption chi n. Ediciones Urmo, 1973. , Fuel Cells and their applicatio	Technologis nts, Springer I. Dincer, an Ilers and he	-Verlag, 1990. nd M. A. Rosen, John				
Student assessment	Exam50%Assignments:40%Attendance:5%Quality and performance of the team work5%								
Contact person	Ivette Rodríguez <u>http://directori.upc.edu/directori/dadesPersona.jsp?id=1004330</u> Yolanda Calventus <u>http://directori.upc.edu/directori/dadesPersona.jsp?id=1002575</u>								
Link									



Master Thesis rules at UPC

Objectives and Scope

The Master Thesis is an individual work where the student must apply and integrate the knowledge and skills acquired throughout the programme. The work should allow a comprehensive assessment of students' professional skills and scientific and technological training, as a prerequisite to achieve the degree MSc in Energy Engineering.

The student under the supervision of a thesis director shall make a written report that reflects the objectives, the methodology, results obtained and conclusions.

Requirements

- The registration is performed at the master secretariat prior to the public defence of the thesis.
- Each thesis shall have a director, who advises and supervises the student.
- To submit the thesis for examination the authorization of the thesis director is required.
- The examination is done by a evaluation committee during a public defence.
- For the defence of the master thesis is necessary that the student has passed all the master courses.
- If the student chooses a specialisation, the master thesis should be related to the area of specialization.

The thesis work must be submitted to the master Secretariat, during the period scheduled at the beginning of each academic year. The student must deliver the following documentation:

- A paper copy of the thesis work in A4 format. This copy should also include the presentation acceptance form signed by the thesis director and the evaluation minutes form (all these forms are available in the Master website).
- A CD / DVD with all the thesis documents in PDF format (in one or several documents). The cover shall include at least the author, director and title.
- The External Director's Report, if applicable.

Examination

The student must present his work during a public defence for a maximum of 40 minutes. Evaluation committee members can make questions and comments to the student. After that, the evaluation committee delivers about the thesis grade. The secretary of the committee completes the examination minutes with the evaluation results. These minutes, which are signed by all committee members and a copy of the thesis work, are delivered to the master secretariat.

Grades are the same than for other UPC courses (0 to 10, where below 5 is not-passed and 10 is an excellent work).



Evaluation committee

The evaluation committees are appointed by the Master Coordinator.

The evaluation committee is composed by three lecturers amongst those of the departments and institutes participating in the master degree, with the possible participation of an external member of the collaborating institutions.