Name of the class: Renewable Energy Technologies Modeling
Course key: 76993
Type of course: Optative
Approved credits:
Last curriculum revision date: September 2020
Pre-requisite: None

A) NAME OF THE COURSE: RENEWABLE ENERGY TECHNOLOGIES MODELING

Synthetic Program										
Renewable Energy Technologies Modeling										
General Information										
Type of curriculum proposal:	New creation	x	Restructuration			Adjustment				
Type of class	Mandatory		Optative	x	Complementary		Other			
Class shared with another EP or academic entity	(X) No ( ) Yes ¿With which PE is shared? _____ ¿Which semester? _____ ¿Which academic entity? _____									
Elaborated by:	Noé Armando Colín Mercado									
Reviewed by:										
Semester	**Hours of theory per week**		**Hours of practice per week**		**Hours of additional work per week**			**Credits**		
	3		1		1			6		
General objective	Know and study renewable energy, as well as its production, adaptation, application and storage for proper operation and installation to the network.									
Specific objective	• Study and analyze solar energy generating systems, know the types of photovoltaic cells, as well as the interconnection in parallel and series mode, to the public network to optimize resources.									

Synthetic Program		
	• Study and analyze wind power generating systems, know the types of helix and turbines, as well as the interconnection in parallel and series mode, to public network to optimize resources. • Study and analyze the biomass systems that generate energy, know the types of gases, their separation and optimum use, as well as the interconnection to public network. • Study and analyze the different types of renewable energy storage, to maximize its use.	
Specific professional competence (s) for which the class contributes.	The students will be able to: • Develop specific research and practices related to energy generation through renewable sources. • Analyze literature, videos and any scientific, academic and / or dissemination media. They will make arguments, discussions and defend their views in oral presentations. • Resolve assessment exams and can make use of information and communication technology in the learning process as a tool to access the globalized world.	
Practices of the specific professional competence for which the class contributes	• The students will commit to acquiring the criteria of quality and relevance of the program to actively contribute to society in the identification of problems and possible solutions to these, from the renewable energy perspective and a sustainability approach that includes economic, political dimensions, social and environmental. • The graduates will have sufficient skills and knowledge to work independently but also as a team.	
Professional transversal (s) competence (s) for which the class contributes	• The students will participate in activities in favor of the Sustainable Development Goals, with Objective 7 being their central axis. Affordable and non-polluting energy. • The students will contribute to equality, peace, eliminate poverty and hunger, as well as protect natural resources and make use of them in a responsible manner.	
Units	**Units**	**Content**
	1. Introduction to renewable energy	It will be presented the main renewable energy sources and their transformation to form electrical and / or mechanical.
	2. Solar energy generating system	It will be studied and analyzed solar energy generating systems, the types of photovoltaic cells, as well as the interconnection in parallel and series mode, to the public network to optimize solar energy resources.
	3. Wind power generation system	It will be studied and analyzed wind power generating systems, the types of helix and turbines, as well as the interconnection in parallel and series mode, to public network to optimize wind power resources.

Synthetic Program			
	4. Energy generating biomass systems	It will be studied and analyzed the biomass systems that generate energy, know the types of gases, their separation and optimum use, as well as the interconnection to public network.	
	5. Energy storage systems	The students will know and analyze different types of renewable energy storage to maximize its use.	
Method and practice	**Method**	Presentation of topics through videos, power point presentations and conferences. The course will be developed mainly as a seminar-workshop. The main attraction of this method lies in the possibility of a collective reflection on each of the topics analyzed during the program. The content of the class will be delivered through readings and presentations in class. The course will be dynamic and participatory, based on discussions. Each student has to deliver an essay on a self-selected topic on renewable energy. In preparation for classes, each student should read a specific article and develop an essay (maximum 1 page), where they must express their OWN opinion, experiences, doubts and / or thoughts. This text must be delivered the night before the next class. The teacher will also provide theoretical presentations and introduce modern topics.	
	Practice	In each of the units a practice will be carried out in which through a software (Workbench) or in a physical way through the simulation of a scale system, the student can reproduce the theory learned in class. Technical visits can also be made to the windy CFE in Oaxaca (wind energy), pig farm in Temacaltepec, Mexico City (biomass energy) or Aurora Sola I in La Paz (solar energy)	
Evaluation method	**Partial Exam**	20 %	First partial exam: unit 1 and 2
		20 %	Second partial exam: unit 3 and 4
		20 %	Third partial exam: unit 5
		40 %	Field practice
	Final exam	It will consist of the average of the evaluations carried out in the partials	
	Other activities		

Bibliography and digital resources	**Bibliography**	Almarza Cano (2010) Electric energy accumulation systems for hydraulic generation plants Biomass: current status and immediate perspective - ICAI (2009) CASTRO GIL, Manuel; Colmenar Santos, Antonio; Sánchez Naranjo, Consuelo. Wind power. 1st reimp. Madrid: PROGENSA, 2001. 50 p. Technical monographs of renewable energies; 1. ISBN 84-86505-68-2AULÍ MELLADO, Enric. Guide to obtain sustainable housing: the keys to ecological, social and economic harmony in your home. Barcelona: CEAC, 2005. 126 p. ISBN 84-329-1091-0 CASTRO GIL, Manuel; Sánchez Naranjo, Consuelo. Biofuels Madrid: PROGENSA, 1997. 44 p. Technical monographs of renewable energies; 3. ISBN 84-86505-70-4 Christian Santana Renewable Energies in Chile: The wind, solar and hydroelectric potential of Arica a Chiloé, Santiago 2014. EDWARDS, Brian; Hyett, Paul. Basic guide to sustainability. 1st ed., 2nd run. Barcelona: Gustavo Gili, 2004. 121 p. ISBN 84-252-1951-5 EICKER, Ursula. Solar technologies for buildings. Chichester: John Medium and high temperature solar thermal energy. Madrid: PROGRENSA, 2000. 69 p. Technical monographs of renewable energies; 6. ISBN 84-86505-87-9 Renewable energies - Jaime González Velasco (2009) Escoda, Salvador (2017). White paper of renewable energies. Edition 18.1, Legal Dep. DL B 26736-2017 Study of a wind energy storage system through batteries - Samuel Vélez Moreno (2012) Fluent - José Antonio Gallego Martín (2014) Godfrey Boyle, Bob Everett and Janet Ramage. Energy systems and sustainability. (2004) Oxford: Oxford University Press, 2004. XVII, 619 p. ISBN 0199261792 Technical guide of thermal biomass installations in buildings - IDEA The energy of plants (2011) Design and Manufacture of a Low Power Hydrogen Fuel Cell - Javier Impact of the incorporation of the electric vehicle in the integration of renewable energies in the electrical system - Nuria Galindo Martín (2010)

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		Jarabo, F .; Fernández, J. (1983). Renewable alternative energies. A future for the Canary Islands? Secretariat of Publications of the University of La Laguna. ISBN 84-600-3085-7 Jarabo, F .; Fernández, J .; Trujillo, D .; Elórtegui, N .; Pérez, C. (1984). The Energy of Biomass. Ed. It was Solar. Madrid Manuel ... [et al.]. (2000). Photovoltaic Solar Energy. CASTRO GIL. Madrid: PROGENSA ,. 68 p. Technical monographs of renewable energies; 7. ISBN 84-86505-89-5 What we do to load the car at home - Pedro de la Mata Gómez (2010) SEVILLE, Alfonso. The energy of the sun and wind. Madrid: Alción, 1992. 111 p. ISBN 84-862445-08-5 SMITH, Kimberly K. Powerig our future: an energy sourcebook for sustainable living. New York: IUniverse, 2005. XXI, 354 p. ISBN 0-595-33929-8 Wiley & Sons, 2001. XII, 323 p. ISBN 0-471-48637-X

Synthetic Program		
	Digital Resources	Energy Agenda Ministry of Chile (2019). http://www.minenergia.cl International Energy Agency (2019). Manual of Energy Statistics. Paris: Eurostat. http://www.acee.cl (IEA / AIE) International Energy Agency: http://www.iea.org IAEA International Atomic Energy Agency: http://www.iaea.org Intergovernmental Panel on Climate Change: http://www.ipcc.ch (OPEC) Organization of the Petroleum Exporting Countries: http://www.opec.org United Nations Framework on Climate Change: http://unfccc.int/portal_espanol/items/3093.php European Environment Agency: http://www.eea.europa.eu/en EURATOM Supply Agency: http://ec.europa.eu/euratom/index.html EPA (Environmental Protection Agency): http://www.epa.gov US Department of Energy (DOE): http://www.energy.gov/engine/content.do OLADE (Latin American Energy Organization): http://www.olade.org NEA (Nuclear Energy Agency): http://www.nea.org

B) CONTENTS AND METHODS BY UNITS AND TOPICS

Unit 1. Types of renewable energy		**12h**
Topic 1.1 Wind energy		**2h**
Subtopic	1.1.1 Definition and scope 1.1.2 Way of obtaining 1.1.3 Use 1.1.4 How to store it	
Topic 1.2 Solar energy		**2h**

Subtopic	1.2.1 Definition and scope 1.2.2 Way of obtaining 1.2.3 Use 1.2.4 How to store it	
Topic 1.3 Hydraulic energy		**2h**
Subtopic	1.3.1 Definition and scope 1.3.2 Way of obtaining 1.3.3 Use 1.3.4 How to store it	
Topic 1.4 Geothermal Energy		**2h**
Subtopic	1.4.1 Definition and scope 1.4.2 Way of obtaining 1.4.3 Use 1.4.4 How to store it	
Topic 1. 5 Tidal energy		**2h**
Subtopic	1.5.1 Definition and scope 1.5.2 Way of obtaining 1.5.3 Use 1.5.4 How to store it	
Bibliography and digital resources	**Bibliography**	**1. Types of renewable energy** Escoda, Salvador (2017). White paper of renewable energies. Edition 18.1, Legal Dep. DL B 26736-2017 Godfrey Boyle, Bob Everett and Janet Ramage. Energy systems and sustainability. (2004) Oxford: Oxford University Press, 2004. XVII, 619 p. ISBN 0199261792 **1.6 Solar energy** Christian Santana Renewable Energies in Chile: The wind, solar and hydroelectric potential of Arica a Chiloé, Santiago 2014.
	Digital resources	**Energy Agenda** Ministry of Chile (2019). http://www.minenergia.cl **International Energy Agency (2019).** Manual of Energy Statistics. Paris: Eurostat. http://www.acee.cl

Unit 2. Solar energy generating systems	**8h**

Topic 2.1 Energy Photovoltaic			**4h**
Subtopic	2.1.1 Definition and scope 2.1.2 Way of obtaining 2.1.3 Use and benefits 2.1.4 How to store and interconnect it to the public network 2.1.5 Practice Development		
Topic 2.2 Solar thermal energy			**4h**
Subtopic	2.2.1 Definition and scope 2.2.2 Way of obtaining 2.2.3 Use and benefits 2.2.4 How to store and interconnect it to the public network 2.2.5 Practice Development		
Bibliography and digital resources	**Bibliography**	**2.1 Photovoltaic solar energy** EICKER, Ursula. Solar technologies for buildings. Chichester: John Wiley & Sons, 2001. XII, 323 p. ISBN 0-471-48637-X Manuel ... [et al.]. (2000). Photovoltaic Solar Energy. CASTRO GIL. Madrid: PROGENSA ,. 68 p. Technical monographs of renewable energies; 7. ISBN 84-86505-89- 5 **2.2 Solar thermal energy** Medium and high temperature solar thermal energy. Madrid: PROGRENSA, 2000. 69 p. Technical monographs of renewable energies; 6. ISBN 84-86505-87-9	
	Digital resources	**Energy Agenda** Ministry of Chile (2019). http://www.minenergia.cl **International Energy Agency (2019).** Manual of Energy Statistics. Paris: Eurostat. http://www.acee.cl	

Unit 3. Wind power generation systems		**4h**
Topic 3 .1 Wind Energy		**4h**
Subtopic	2.1.1 Definition and scope 2.1.2 Way of obtaining and calculating generation 2.1.3 Use and benefits	

	2.1.4 How to store and interconnect it to the public network 2.1.5 Propeller design and development 2.1. 6 Practice development	
Bibliography and digital resources	**Bibliography**	**3.1 Wind energy** SEVILLE, Alfonso. The energy of the sun and wind. Madrid: Alción, 1 992. 111 p. ISBN 84-862445-08-5 SMITH, Kimberly K. Powerig our future: an energy sourcebook for sustainable living. New York: IUniverse, 2005. XXI, 354 p. ISBN 0-595-33929-8 CASTRO GIL, Manuel; Colmenar Santos, Antonio; Sánchez Naranjo, Consuelo. Wind power. 1st reimp. Madrid: PROGENSA, 2001. 50 p. Technical monographs of renewable energies; 1. ISBN 84-86505-68-2
	Digital resources	**Europe** European Environment Agency: http://www.eea.europa.eu/en EURATOM Supply Agency: http://ec.europa.eu/euratom/index.html **USA** : EPA (Environmental Protection Agency): http://www.epa.gov US Department of Energy (DOE): http://www.energy.gov/engine /content.do **Latin America** : OLADE (Latin American Energy Organization): http://www.olade.org NEA (Nuclear Energy Agency): http://www.nea.org/

Unit 4. Energy generating biomass systems		**10 h**
Topic 4.1 Biomass		**4 h**
Subtopic	2.1.1 Definition and scope 2.1.2 Way of obtaining 2.1.3 Use and benefits 2.1.4 How to store and interconnect it to the public network 2.1.5 Practice Development	
Topic 4.2 Natural biomass		**3h**
Subtopic	4.2.1 Definition and scope 4.2.2 Thermal Energy Production	

	4.2.3 Electric Power Production 4.2.4 Biofuel Production 4.2.5 Production of Combustible Gases	
Topic 4 . 3 Residual Biomass		**3h**
Subtopic	4.3.1 Definition and scope 4.3.2 Thermal Energy Production 4.3.3 Electric Power Production 4.3.4 Biofuel Production 4.3.5 Fuel Gas Production	
Bibliography and digital resources	**Bibliography**	**4. Energy generating biomass systems** AULÍ MELLADO, Enric. Guide to obtain sustainable housing: the keys to ecological, social and economic harmony in your home. Barcelona: CEAC, 2005. 126 p. ISBN 84-329-1091-0 CASTRO GIL, Manuel; Sánchez Naranjo, Consuelo. Biofuels Madrid: PROGENSA, 1997. 44 p. Technical monographs of renewable energies ; 3. ISBN 84-86505-70-4 EDWARDS, Brian; Hyett, Paul. Basic guide to sustainability. 1st ed., 2nd run. Barcelona: Gustavo Gili, 2004. 121 p. ISBN 84-252-1951-5 Renewable energies - Jaime González V elasco (2009) Biomass: current status and immediate perspective - ICAI (2009) Technical guide of thermal biomass installations in buildings - IDEA The energy of plants (2011)
	Digital resources	(IEA / AIE) International Energy Agency: http://www.iea.org IAEA International Atomic Energy Agency: http://www.iaea.org Intergovernmental Panel on Climate Change: http://www.ipcc.ch (OPEC) Organization of the Petroleum Exporting Countries: http://www.opec.org United Nations Framework on Climate Change: http://unfccc.int/portal_espanol/items/3093.php

Unit 5. Energy storage systems	**14h**
Topic 5 .1 Biological storage	**4h**

Subtopic	5 .1.1 Definition and scope 5 .1.2 E elements that make it up 5 .1.3 Use and benefits 5 .1.4 Disadvantages 5 .1.5 Development of practice	
Topic 5 .2 Thermal storage		**3h**
Subtopic	5.2.1 Definition and scope 5.2.2 The elements that make it up 5.2.3 Use and benefits 5.2.4 Disadvantages 5.2.5 Practice Development	
Topic 5.3 Mechanical storage		**3h**
Subtopic	5.3.1 Definition and scope 5.3.2 The elements that make it up 5.3.3 Use and benefits 5.3.4 Disadvantages 5.3.5 Practice development	
Topic 5.4 Chemical and electrochemical storage		**4h**
Subtopic	5.4.1 Definition and scope 5.4.2 The elements that make it up 5.43 Use and benefits 5.4.4 Disadvantages 5.4.5 Practice development	

Bibliography and digital resources	**Bibliography**	**5. Energy storage systems** Design and Manufacture of a Low Power Hydrogen Fuel Cell - Javier Almarza Cano (2010) Electric energy accumulation systems for hydraulic generation plants Fluent - Jos and Antonio Gallego Martín (2014) Impact of the incorporation of the electric vehicle in the integration of renewable energies in the electrical system - Nuria Galindo Martín (2010) What we do to load the car at home - Pedro de la Mata Gómez (2010) Study of a wind energy storage system through batteries - Samuel Vélez Moreno (2012)
	Digital resources	

C) TEACHING AND LEARNING STRATEGIES

Presentation of topics through videos, power point presentations and conferences. The course will be developed mainly as a seminar-workshop. The main attraction of this method lies in the possibility of a collective reflection on each of the topics analyzed during the program. The content of the class will be delivered through readings and presentations in class. The course will be dynamic and participatory, based on discussions. Each student has to deliver an essay on a self-selected topic on renewable energy.

In preparation for classes, each student should read a specific article and develop an essay (maximum 1 page), where they must express their own opinion, experiences, doubts and / or thoughts. This text must be delivered the night before the next class. The teacher will also provide theoretical presentations and introduce modern topics.

D) EVALUATION AND ACCREDITATION

Preparation and / or presentation of:	Periodicity	Covers	Weighting of each partial in relation to the ordinary
First partial exam: Oral essay presentation	At the end of Unit 2	Unit 1 and 2	20 %
Second partial exam: Written essay presentation	At the end of Unit 4	Unit 3 to 4	20 %
Third partial exam: Final essay presentation	At the end of Unit 5	Unit 5	20 %
Field Practice	-	-	40 %
		TOTAL	100 %
Ordinary exam	The final ordinary grade is composed by three partial ratings (60%) and rating the grade of the practical exercise (40%).		
Other academic activities required	Special non-mandatory activities will not have a value in the partial evaluation. This consists of attending special events on the subject or participation as organizers in events of the discipline, whether from the Faculty or outside it as dissemination and training activities		

E) BIBLIOGRAPHY AND DIGITAL RESOURCES

Basic Texts

Almarza Cano (2010) Electric energy accumulation systems for hydraulic generation plants

Biomass: current status and immediate perspective - ICAI (2009)

CASTRO GIL, Manuel; Colmenar Santos, Antonio; Sánchez Naranjo, Consuelo. Wind power. 1st reimp. Madrid: PROGENSA, 2001. 50 p. Technical monographs of renewable energies; 1. ISBN 84-86505-68-2AULÍ MELLADO, Enric. Guide to obtain sustainable housing: the keys to ecological, social and economic harmony in your home. Barcelona: CEAC, 2005. 126 p. ISBN 84-329-1091-0

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(IEA / AIE) International Energy Agency: http://www.iea.org

IAEA International Atomic Energy Agency: http://www.iaea.org

Intergovernmental Panel on Climate Change: http://www.ipcc.ch

(OPEC) Organization of the Petroleum Exporting Countries: http://www.opec.org

United Nations Framework on Climate Change: http://unfccc.int/portal_espanol/items/3093.php

European Environment Agency: http://www.eea.europa.eu/en

EURATOM Supply Agency: http://ec.europa.eu/euratom/index.html

EPA (Environmental Protection Agency): http://www.epa.gov

US Department of Energy (DOE): http://www.energy.gov/engine/content.do

OLADE (Latin American Energy Organization): http://www.olade.org

NEA (Nuclear Energy Agency): http://www.nea.org/