Course Syllabus (Proyecto/Guía docente de la asignatura)

Subject	THE ENVIRONMENT AND RENEWABLE ENERGY		
Degree	INDUSTRIAL ENGINEERING INTERNATIONAL SEMESTER		
	TRANSVERSAL COURSE FOR THE SEVEN BACHELOR'S DEGREES TAUGHT IN INDUSTRIAL ENGINEERING		
Code	75003		
Semester	Second semester		
Type	Elective		
ECTS credits	6		
Lenguage	English		
Teaching staff (contact information)	*Raúl Muñoz Torre*	*Venue: Doctor Mergelina*	*mutora@iq.uva.es*
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Departments	Chemical Engineering and Environmental Technology		
	Electrical Engineering		

1. Sense of the Course (Situación / Sentido de la Asignatura)

1.1 Contextualization (Contextualización)

The subject is part of the International Semester. It is one of the three subjects that students can choose to study in addition to the final project

1.2 Relationship with other subjects (Relación con otras materias)

The elective subjects that the student can choose in the international semester are:

- Creativity and Innovation in Industrial Design
- Science, Technology and Society
- System Dynamics. Modelling and Simulation in Engineering
- **Environment and Renewable Energy**
- Technical Projects Development and Manufacturing Engineering
- Spanish Course.- Language Centre

1.3 Recommended Prior Knowledge (Prerrequisitos)

No previous knowledge is required to follow the content of the course

2. Competences

2.1 Generic competences

- English language proficiency.
- Team Leadership.
- Creativity.
- Organizational and planning issues.
- Information management.
- Work in international environments.
- Problem solving
- Scientific communication

2.2 Specific competences

- Capability to understand environmental problems related to air, water and soil
- Ability to demonstrate knowledge on environmental policies and pollution prevention
- Ability to analyse and propose solutions to real environmental problems based on the implementation of BAT, sustainability metrics and DfE
- Design, analysis and planning of photovoltaic components and systems for a general purpose, either autonomous or grid connected.
- Analysis, design and implementation of photovoltaic systems of low-mid level of complexity.

3. Course goals

- Students will be able to identify the environmental impacts of the industrial activity and to suggest different options for waste minimization
- Students will be able to explain the basis of sustainability, life cycle Assessment and design for the environment and to apply these concepts to real situations.
- Students will be able to explain how the solar photovoltaic energy works and which the main types of PV systems are.
- Students will be able of identifying the component parts of a photovoltaic system.
- Students will be able to describe the differences between an isolated, grid connected and own-consumption photovoltaic system.

4. Learning Units

Unit 1: "Industrial activity and Environment"

Workload in credits ECTS (Carga de trabajo en créditos ECTS): 2

a. Course goals (Objetivos de aprendizaje)

- Students will be able to identify the environmental impacts of the industrial activity and to suggest different option for waste minimization.

b. Contents (Contenidos)

- Introduction to air, water and soil pollution
- Hazardous waste management
- Natural resources depletion
- Environmental policies
- Pollution prevention and waste minimization
- Best Available Techniques
- Sustainability
- Introduction to sustainability metrics.

c. Bibliography (Bibliografía)

- Edward S. Rubin. Introduction to Engineering and the Environment. McGraw-Hill International Edition 2001
- Paul L. Bishop. Pollution prevention: Fundamentals and Practice. McGraw-Hill International editions. 2000
- The Sustainability Metrics: Sustainable Development Progress Metrics for use in Process Industries. Institution of Chemical Engineers (www. Icheme.org)
- Best Available Techniques. Reference documents under the IPPC Directive and the IED (http://eippcb.jrc.ec.europa.eu/reference/).

d. Timing (Temporalización)

CARGA ECTS	PERIODO PREVISTO DE DESARROLLO
2 credits	First 5 weeks of the semester.

Unit 2: "Biogas and Biomethane"

Workload in credits ECTS (Carga de trabajo en créditos ECTS): 0.8

a. Course goals (Objetivos de aprendizaje)

- Students will be able to explain the basis of biogas production and the commercial and emerging technologies for biogas upgrading.

b. Contents (Contenidos)

Introduction to biogas and biomethane production

Status of biogas and biomethane production in Europe and in the world

Physico-Chemical Biogas Upgrading Technologies

Biological Biogas Upgrading Technologies

Alternative uses of Biogas

c. Bibliography (Bibliografía)

Muñoz R, Meier L., Diaz I, Jeison D (2015) A critical review on the state-of-the-art of physical/chemical and biological technologies for an integral biogas upgrading. Reviews in Environmental Science and Bio/Technology 14:727-759.

d. Timing (Temporalización)

CARGA ECTS	PERIODO PREVISTO DE DESARROLLO
0.8 credits	Weeks 6, 7

Unit 3: "Life Cycle Assessment and Design for the Environment"

Workload in credits ECTS (Carga de trabajo en créditos ECTS): 1.2

a. Course goals (Objetivos de aprendizaje)

- Students will be able to explain the basis of sustainability, life cycle Assessment and design for the environment and to apply these concepts to real situations.

b. Contents (Contenidos)

- Introduction to LCA: History of LCA, objective and structure
- Goal definition and Scoping Stage
- Inventory Analysis
- Impact analysis
- Improvement analysis
- Design for the environment
- Common guidelines in eco-design
- Biomimicry
- Green Chemistry

c. Bibliography (Bibliografía)

- Paul L. Bishop. Pollution prevention: Fundamentals and Practice. McGraw-Hill International editions. 2000
- http://www.ted.com/
- Guinee et al (2001) Life cycle assessment – an operational guide to the ISO standards.
- Prepared by CML, Leiden University, The Netherlands.
- Hertwich E (2011), from lectures in NTNU PhD course Life-cycle assessment and Environmental Systems Analysis EP8108, October 2011
- Hertwich EG and Hammitt JK (2001), A Decision-Analytic Framework for Impact Assessment,International Journal of Life Cycle Assessment, 2001, 6(5), pp. 265-271.

d. Timing (Temporalización)

CARGA ECTS	PERIODO PREVISTO DE DESARROLLO
1.2 credits	Weeks 8, 9, 10

Unit 4: "Photovoltaic systems"

Workload in credits ECTS (Carga de trabajo en créditos ECTS): 2

a. Course goals (Objetivos de aprendizaje)

- Students will be able to explain how the solar photovoltaic energy works and which the main types of PV systems are.
- Students will be able of identify the component parts of a photovoltaic system.
- Students will be able to describe the differences between an isolated, grid connected and own-consumption photovoltaic system.

b. Contents (Contenidos)

- Introduction
- General description of PV systems
- Basic concepts of electricity
- PC software package for the study, sizing and data analysis of PV systems (PVSyst).
- PV panel: I-V and P-V curves.
- Laboratory stand alone PV system.
- Laboratory grid connected PV system.
- Laboratory own-consumption PV system.
- Use of PVGIS web to provide information about PV systems performance

The performance of the laboratory practices will be subject to the individual protection and physical distance measures necessary to preserve the health of the students, teachers and PAS involved in the development of the practices, and to the material means available and individual protection provided by the University of Valladolid and the School of Industrial Engineering. If health and organizational circumstances so require, they may be replaced by equivalent teaching and training activities that guarantee the acquisition of knowledge and the development of skills

c. Bibliography (Bibliografía)

- Solar Energy: The physics and engineering of photovoltaic conversion, technologies and systems by Arno Smets; Klaus Jager; Olindo Isabella; Rene van Swaaij. UIT Cambridge, 2016
- Solar Electricity Handbook – 2019 Edition: A simple, practical guide to solar energy – designing and installing solar photovoltaic systems. Michael Boxwell. Greenstream Publishing; Edition: 2019
- ABB. "Cuaderno de aplicaciones técnicas nº 10: Plantas fotovoltaicas". 2011.
- Lorenzo Pigueras, Eduardo- "Electricidad solar fotovoltaica. 3, Radiación solar y dispositivos fotovoltaicos", Sevilla, Progensa 2006.

d. Timing (Temporalización)

CARGA ECTS	PERIODO PREVISTO DE DESARROLLO
2 credits	Weeks 11- 15 of the semester.

5. Teaching and Learning Methods (Métodos docentes y principios metodológicos)

The course consists of 3 learning units; each one is divided into theoretical lessons, practices, in-group corrections or checking, concerted tutorials and technical visits.

The lectures will mainly use oral presentation for teaching the fundamental knowledge of the subject. Active student participation will be encouraged.

The practical lessons will support the understanding and assimilation of the concepts provided in theoretical lectures. The assignments will be done individually or in small groups, depending on the activity and the number of students enrolled. Some of the assignments will be done in the classroom and at home. The assignments of each learning unit will be presented to the lecturer and other students and handed in to the teacher within the deadlines indicated in the schedule presented at the beginning of the course

Tutorials will involve personal assistance and will be carried out individually or in small groups in order to monitor the proper development of the work prior to final assignment submission. These tutorials should be previously arranged.

The visits will take place in full-scale industrial facilities in order to understand the differences between real and lab-scale systems.

The student will also present some of the assignments to the rest of the classroom.

6. Dedication of the student to the subject (Tabla de dedicación del estudiante a la asignatura)

PRESENTIAL ACTIVITIES or PRESENTIAL DISTANCE ACTIVITIES (1) ACTIVIDADES PRESENCIALES o PRESENCIALES A DISTANCIA(1)	HOURS (HORAS)	NON PRESENTIAL ACTIVITIES (ACTIVIDADES NO PRESENCIALES)	HOURS (HORAS)
Unit 1: "Industrial activity and Environment"	20	Student personal work	30
Unit 2: "Biogas and biomethane"	8	Student personal work	12
Unit 3: "Life Cycle Assessment and Design for the Environment"	12	Student personal work	18
Unit 4: "Photovoltaic systems"	20	Student personal work	30
Total presential	**60**	**Total non presential**	**90**

(1) Presential distance activity is when a group follows a videoconference synchronously to the class given by the teacher.

7. Activities evaluated and grading system (Sistema y características de la evaluación)

The Spanish University System provides to the students two calls:

- The first call grading system is based on a continuous assessment and will be held according to the following parameters:
  - Attendance: 25%
  - Activities and Assignments made in Learning Unit 1: 25%
  - Activities and Assignments made in Learning Unit 2: 10%
  - Activities and Assignments made in Learning Unit 3: 15%
  - Activities and Assignments made in Learning Unit 4: 25%

It is essential to pass each individual unit in order to pass the course. If the students fail in the first call, they have another option to pass the subject in the second call

- The grading of students in the second call will be held according to the following parameters:
  - Exam of the contents presented in lectures: 25%
  - Activities and Assignments made in Learning Unit 1: 25%
  - Activities and Assignments made in Learning Unit 2: 10%
  - Activities and Assignments made in Learning Unit 3: 15%
  - Activities and Assignments made in Learning Unit 4: 25%

It is essential to pass each individual unit in order to pass the course

8. Additional Considerations (Consideraciones finales)

The course is configured in such a way that it requires the presence of the student for its effective use, although videoconference lesson might be implemented if needed. The means of communication with the students will be the subject page on the Virtual Campus of the University of Valladolid. On this page, information will be provided about its development and support material will be published for the teaching given in the classroom. This material can be used as a guide to the subject matter explained, but it is not intended to be exclusive material for study; the student should complete it with his notes and the recommended bibliography.