320006 - TMS - Environmental Technologies and Sustainability

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering
702 - CMEM - Department of Materials Science and Metallurgy
709 - EE - Department of Electrical Engineering

Academic year: 2018
Degree: BACHELOR'S DEGREE IN INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN TEXTILE TECHNOLOGY AND DESIGN ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)

ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: Enric Carrera Gallissà, Antoni Escalas Cañellas
Others: Enric Carrera Gallissà, Juan Martínez Magaña, María Dolores Alvarez del Castillo, Gemma Molins Duran, Antoni Escalas Cañellas, Joaquim Olivé Duran, Ricard Giné Garriga

Degree competences to which the subject contributes

Specific:
5. AUD: Ability to apply environmental technologies and sustainability principles.
7. IND_COMMON: Ability to apply environmental technologies and sustainability principles.
8. (ENG) Coneixements bàsics i aplicació de tecnologies mediambientals i sostenibilitat

Transversal:
3. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 1. Analyzing the world’s situation critically and systemically, while taking an interdisciplinary approach to sustainability and adhering to the principles of sustainable human development. Recognizing the social and environmental implications of a particular professional activity.
6. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.
The subject is divided into two parts: sustainability and environmental technologies. The aim of the first part is to present the basic principles and fundamentals of the sustainable development paradigm, the factors that have led to the unsustainability of today's society, the current state of the world, and development models and policies from a systemic perspective and considering the logic of complexity. They will become familiar with the mechanisms underlying different economic models and the implications for, and influence on, business administration. The aim of the second part, in which students will already be familiar with the principles of sustainability, is to describe the main environmental technologies (water, energy, waste and air pollution management), the environmental management and assessment technologies that can contribute to a sustainable society, and the environmental technology that is best suited to each situation.

### Learning objectives of the subject

The subject is divided into two parts: sustainability and environmental technologies. The aim of the first part is to present the basic principles and fundamentals of the sustainable development paradigm, the factors that have led to the unsustainability of today's society, the current state of the world, and development models and policies from a systemic perspective and considering the logic of complexity. They will become familiar with the mechanisms underlying different economic models and the implications for, and influence on, business administration. The aim of the second part, in which students will already be familiar with the principles of sustainability, is to describe the main environmental technologies (water, energy, waste and air pollution management), the environmental management and assessment technologies that can contribute to a sustainable society, and the environmental technology that is best suited to each situation.

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 15h</th>
<th>Hours medium group: 30h</th>
<th>Hours small group: 0h</th>
<th>Guided activities: 0h</th>
<th>Self study: 105h</th>
<th></th>
</tr>
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<tbody>
<tr>
<td>10.00%</td>
<td>20.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>70.00%</td>
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- Face-to-face lecture sessions.
- Face-to-face practical work sessions.
- Independent learning and exercises.
- Preparation and completion of group activities subject to assessment.

In the face-to-face lecture sessions, the lecturer will introduce the basic theory, concepts, methods and results for the subject and use examples to facilitate students' understanding.

There will be three types of practical work sessions:

a) Sessions in which the lecturer provides students with guidelines for analysing data and solving problems using techniques, concepts and theoretical results.
b) Sessions in which students present group work.
c) Examination sessions

Students will be expected to study in their own time so that they are familiar with concepts and are able to solve the exercises set, whether manually or with the help of a computer.
## Topic 1: State of the World

<table>
<thead>
<tr>
<th>Description:</th>
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<tbody>
<tr>
<td>1.1. Carrying capacity.</td>
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<tr>
<td>1.2. Population.</td>
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<tr>
<td>1.3. Economy, inequalities and social impacts.</td>
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<tr>
<td>1.4. Impacts of human activity. Ecological footprint</td>
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<table>
<thead>
<tr>
<th>Related activities:</th>
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<tbody>
<tr>
<td>P0: Presentation of the activities</td>
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<tr>
<td>P01: State of the world</td>
</tr>
<tr>
<td>P02: Ecological footprint</td>
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<table>
<thead>
<tr>
<th>Specific objectives:</th>
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<tbody>
<tr>
<td>For students to:</td>
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<tr>
<td>- Understand the concept of carrying capacity and its influencing factors, as applied to humankind.</td>
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<td>- Understand the evolution of the world's population in terms of volume, and also disaggregated into regions or rural and urban areas. Understand how the demographic transition model enables the data to be interpreted.</td>
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<tr>
<td>- Understand the bases of the economic model of growth and its quantitative evolution. Understand economic and social imbalances on a worldwide scale and analyse their main consequences and causes.</td>
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<tr>
<td>- Understand the basic resources used and the main forms of waste generated by human activity, as well as the resulting environmental impacts. Analyse the relationship between these impacts and the development model. Become familiar with indicators of these impacts, such as the ecological footprint.</td>
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### Learning time:
- Theory classes: 1h
- Practical classes: 2h
- Self study: 6h
### TOPIC 2: CAUSES OF UNSUSTAINABILITY

**Description:**
- 2.1. A problematic model.
- 2.2. The Copernican revolution and mechanism.
- 2.3. Utilitarianism, anthropocentrism and technocracy.
- 2.4. The sacrifice of equity.
- 2.5. The prisoner's dilemma.
- 2.6. The example of Easter Island.

**Related activities:**
P03: CAUSES OF UNSUSTAINABILITY

**Specific objectives:**
- Understand that "reality" is a relative concept that is interpreted and constructed differently in each cultural context.
- Understand the foundations of our worldview, especially the elements that underlie the current unsustainability.

### TOPIC 3: THE SUSTAINABILITY PARADIGM

**Description:**
- 3.1. Historical background.
- 3.2. Introduction to the concept of sustainable development. Discussion.
- 3.3. World summits and institutional initiatives.
- 3.4. The equation I = P*C*T.
- 3.5. The capital-based approach. Strong and weak sustainability.
- 3.6. The principles of sustainability.

**Related activities:**
P06: POLICIES AND SUSTAINABILITY

**Specific objectives:**
For students to:
- Understand the historical background to the concept of sustainable development.
- Become familiar with different perspectives on the concept of sustainable development.
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## TOPIC 4: SYSTEMICS AND COMPLEXITY

<table>
<thead>
<tr>
<th>Learning time: 9h</th>
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<tr>
<td>Theory classes: 1h</td>
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<tr>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td>Self study: 6h</td>
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### Description:

- **4.1.** Systemics: a new way of understanding and representing reality and needs.
- **4.2.** Technology as a system.
- **4.3.** The quality of the system and the phenomenon of emergence. The expanded concept of complexity.
- **4.4.** The concept and dynamics of systems.
- **4.5.** The principles of systems thinking.

### Related activities:

P05: WORLD ORGANISATIONS

### Specific objectives:

For students to:
- Understand the concept of paradigms and mind maps and know how they are used to understand and analyse reality.
- Understand the implications of the paradigm of complexity and systemics in addressing, understanding and acting on reality.
- Understand the distinction between restricted complexity and general complexity.
- Understand the basic concepts of systemics and their implications.
- Become aware of the non-neutrality of technology and the importance of considering technology in its context, as well as in the current context of technological development.
## TOPIC 5: DEVELOPMENT MODELS

### Learning time:
9h
- Theory classes: 1h
- Practical classes: 2h
- Self study: 6h

### Description:
5.1. The various aspects of development:
- 5.1.1. The origin of the concept of development.
- 5.1.2. The various aspects of development.
- 5.1.3. Development as a complex dynamic phenomenon.
- 5.2. Human development and well-being:
  - 5.2.1. Oikonomia and chrematistics: the emergence of the modern free-market model.
  - 5.2.2. Fake goods: the crises of modern sustainability.
  - 5.2.3. Needs and development.
  - 5.2.4. Criticism of political ecology: the welcoming society and post-industrial utopias.
  - 5.2.5. Human-scale development.
  - 5.2.6. The capability approach and the UNDP's human development proposal.
- 5.2.7. Alternative models of human development.

### Related activities:
P04: DEVELOPMENT MODELS

### Specific objectives:
For students to:
- Understand development as a multifaceted phenomenon comprising social, cultural, political, economic, institutional, technological, environmental and ecological aspects.
- Understand the interdependence between these dimensions and their conditioning factors.
- Understand the role of technology, engineering and cooperation in global change.
- Understand the concept of human development and well-being.
- Understand the main proposals of human development models: political ecology proposals, the model of human-scale development, and the human development of the UNDP.
### TOPIC 6: POLITICS AND SUSTAINABILITY

**Learning time:** 10h  
- Theory classes: 1h  
- Practical classes: 2h  
- Self study: 7h

**Description:**

**Related activities:**
- P06. The economy of common well

**Specific objectives:**  
For students to:  
- Understand the basics of collective decision-making systems, including democracy and citizen participation. Analyse the characteristics of these systems.  
- Become familiar with today’s main global governance institutions: the UN, the IMF, the WB and the WTO. Become familiar with their main programmes, activities and applications.  
- Understand historical globalism theory and some of the new global governance proposals that have arisen in this context.

### TOPIC 7: ENVIRONMENTAL IMPACTS AND MANAGEMENT TOOLS

**Learning time:** 22h  
- Theory classes: 2h  
- Practical classes: 2h  
- Self study: 18h

**Description:**
- 7.1. Environmental impacts of technology, industry, services and infrastructure.  
- 7.2. Environmental management:  
  - 7.2.1. Environmental audits.  
  - 7.2.2. Environmental impact assessments.  
  - 7.2.3. Environmental management systems.  
  - 7.2.4. Lifecycle analysis.  
  - 7.2.5. Eco-design.  
  - 7.2.6. Eco-labelling.  
  - 7.2.7. Industrial ecology, clean technologies and best available technologies.  

**Related activities:**
- P12: ENVIRONMENTAL MANAGEMENT TOOLS

**Specific objectives:**  
For students to:  
- Identify and understand the environmental impacts of any sort of activity.  
- Determine and understand where the various environmental management tools should be applied in order to reduce the impacts of an activity. Understand the advantages of making environmental management an integral part of an activity.  
- Understand, identify and assess the application of clean technologies and best available technologies in an activity.
### TOPIC 8: WATER MANAGEMENT

**Learning time:** 9h  
Theory classes: 1h  
Practical classes: 2h  
Self study: 6h

**Description:**
- 8.1. Water resources.
- 8.2. Uses of water. Sources of pollution.
- 8.3. Sustainability indicators: environmental and socioeconomic.
- 8.5. Demand management.

**Related activities:**
P07: WATER MANAGEMENT

**Specific objectives:**
For students to:
- Identify and understand the environmental significance of the main indicators of water quality.
- Identify the main treatments applied in order to soften and purify water and make it potable.

### TOPIC 9: WASTE MANAGEMENT

**Learning time:** 9h  
Theory classes: 1h  
Practical classes: 2h  
Self study: 6h

**Description:**

**Related activities:**
P10: WASTE MANAGEMENT

**Specific objectives:**
For students to:
Identify the main management models and technologies for assessing/treating municipal and industrial waste.
### TOPIC 10: ENERGY

**Learning time:** 9h  
Theory classes: 1h  
Practical classes: 2h  
Self study : 6h

**Description:**  
10.1. The concept of energy.  
10.2. The dispersion of energy.  
10.3. The different forms of energy.  
10.4. Trends in energy use.  
10.5. Implications: ecological footprint and peak oil.  
10.6. Alternative energy sources.  
10.6.1. The energy debate.  
10.6.2. Efficiency and renewable energy sources.

**Related activities:**  
P08: ENERGY

**Specific objectives:**  
For students to:  
- Identify problems associated with energy consumption as relates to emissions and reserves.  
- Identify improvement proposals related to renewable energy sources and energy efficiency.

### TOPIC 11: AIR POLLUTION

**Learning time:** 27h  
Theory classes: 2h  
Practical classes: 6h  
Self study : 19h

**Description:**  
11.1. Atmosphere.  
11.2. Main air pollutants and emission sources.  
11.3. The effects of pollution.  
11.4. Air-quality indicators (ICQA).  
11.5. Description of the main elimination-treatment technologies and gaseous pollutants.

**Related activities:**  
P09: Gas emissions.  
P11: Pollution problem

**Specific objectives:**  
For students to:  
- Identify the main air pollutants and emission sources.  
- Determine air-quality indices.  
- Describe the main treatment technologies for eliminating particles and gaseous pollutants.
Qualification system

Oral or written tests: 60%
- 1st bimester, weight: 30%
- 2nd bimester, weight: 30%
Practical work: 40%

Redirection of unsatisfactory assessment results:
- A resit examination will be done for the mid-term exam, exclusively for the course groups where the weight of the mid-term exam (1st bimester exam) is greater than 25%, in application of the ESEIAAT regulations for redirection of unsatisfactory assessments results. This resit examination will consist of a “redirection exam” having the same format and the same base of contents as the mid-term exam.
- This "redirection exam" will take place at the same classroom, day and time assigned to the final exam, i.e., the student taking the resit exam will have 3 hours to do the final exam (2nd bimester exam) and the "redirection exam".
- Who will have the right to take the "redirection exam"? For the course groups mentioned above, the students that, having a mark less than 5.0 in the mid-term exam, place a request for the "redirection exam". This request will be placed to the professor responsible for his or her course group, under the terms and deadline set by the professor.
- The mark of the "redirection exam" will replace the mark of the mid-term exam as far as the mark of the "redirection exam" is greater than the mark of the mid-term exam.
Bibliography

Basic:


Complementary:


Others resources:

Tecnologia i Sostenibilitat. http://tecnologiaisostenibilitat.cus.upc.edu