

## 320006 - TMS - Environmental Technologies and Sustainability

Coordinating unit:	205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit:	702 - CMEM - Department of Materials Science and Metallurgy 713 - EQ - Department of Chemical Engineering 709 - EE - Department of Electrical Engineering
Academic year:	2019
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.

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### Teaching methodology

- 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.

### 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

Total learning time: 150h	Hours large group:	15h	10.00%
	Hours medium group:	30h	20.00%
	Hours small group:	0h	0.00%
	Guided activities:	0h	0.00%
	Self study:	105h	70.00%

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### Content

#### TOPIC 1: STATE OF THE WORLD

Learning time: 9h

Theory classes: 1h  
Practical classes: 2h  
Self study : 6h

#### Description:

- 1.1. Carrying capacity.
- 1.2. Population.
- 1.3. Economy, inequalities and social impacts.
- 1.4. Impacts of human activity. Ecological footprint

#### Related activities:

- P0: Presentation of the activities  
P01: STATE OF THE WORLD  
P02: ECOLOGICAL FOOTPRINT

#### Specific objectives:

For students to:

- Understand the concept of carrying capacity and its influencing factors, as applied to humankind.
- 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.
- 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.
- 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.

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<p>TOPIC 2: CAUSES OF UNSUSTAINABILITY</p>	<p>Learning time: 9h Theory classes: 1h Practical classes: 2h Self study : 6h</p>
<p>Description:</p> <ul style="list-style-type: none"> <li>2.1. A problematic model.</li> <li>2.2. The Copernican revolution and mechanism.</li> <li>2.3. Utilitarianism, anthropocentrism and technocracy.</li> <li>2.4. The sacrifice of equity.</li> <li>2.5. The prisoner's dilemma.</li> <li>2.6. The example of Easter Island.</li> </ul> <p>Related activities:</p> <p>P03: CAUSES OF UNSUSTAINABILITY</p> <p>Specific objectives:</p> <ul style="list-style-type: none"> <li>- Understand that "reality" is a relative concept that is interpreted and constructed differently in each cultural context.</li> <li>- Understand the foundations of our worldview, especially the elements that underlie the current unsustainability.</li> </ul>	
<p>TOPIC 3: THE SUSTAINABILITY PARADIGM</p>	<p>Learning time: 9h Theory classes: 1h Practical classes: 2h Self study : 6h</p>
<p>Description:</p> <ul style="list-style-type: none"> <li>3.1. Historical background.</li> <li>3.2. Introduction to the concept of sustainable development. Discussion.</li> <li>3.3. World summits and institutional initiatives.</li> <li>3.4. The equation <math>I = P \cdot C \cdot T</math>.</li> <li>3.5. The capital-based approach. Strong and weak sustainability.</li> <li>3.6. The principles of sustainability.</li> </ul> <p>Related activities:</p> <p>P06: POLICIES AND SUSTAINABILITY</p> <p>Specific objectives:</p> <p>For students to:</p> <ul style="list-style-type: none"> <li>- Understand the historical background to the concept of sustainable development.</li> <li>- Become familiar with different perspectives on the concept of sustainable development.</li> </ul>	

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<p>TOPIC 4: SYSTEMICS AND COMPLEXITY</p>	<p>Learning time: 9h Theory classes: 1h Practical classes: 2h Self study : 6h</p>
<p>Description:</p> <ul style="list-style-type: none"> <li>4.1. Systemics: a new way of understanding and representing reality and needs.</li> <li>4.2. Technology as a system.</li> <li>4.3. The quality of the system and the phenomenon of emergence. The expanded concept of complexity.</li> <li>4.4. The concept and dynamics of systems.</li> <li>4.5. The principles of systems thinking.</li> </ul> <p>Related activities:</p> <p>P05: WORLD ORGANISATIONS</p> <p>Specific objectives:</p> <p>For students to:</p> <ul style="list-style-type: none"> <li>- Understand the concept of paradigms and mind maps and know how they are used to understand and analyse reality.</li> <li>- Understand the implications of the paradigm of complexity and systemics in addressing, understanding and acting on reality.</li> <li>- Understand the distinction between restricted complexity and general complexity.</li> <li>- Understand the basic concepts of systemics and their implications.</li> <li>- 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.</li> </ul>	

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<p>TOPIC 5: DEVELOPMENT MODELS</p>	<p>Learning time: 9h Theory classes: 1h Practical classes: 2h Self study : 6h</p>
<p>Description:</p> <ul style="list-style-type: none"> <li>5.1. The various aspects of development:             <ul style="list-style-type: none"> <li>5.1.1. The origin of the concept of development.</li> <li>5.1.2. The various aspects of development.</li> <li>5.1.3. Development as a complex dynamic phenomenon.</li> </ul> </li> <li>5.2. Human development and well-being:             <ul style="list-style-type: none"> <li>5.2.1. Oikonomia and chrematistics: the emergence of the modern free-market model.</li> <li>5.2.2. Fake goods: the crises of modern sustainability.</li> <li>5.2.3. Needs and development.</li> <li>5.2.4. Criticism of political ecology: the welcoming society and post-industrial utopias.</li> <li>5.2.5. Human-scale development.</li> <li>5.2.6. The capability approach and the UNDP's human development proposal.</li> <li>5.2.7. Alternative models of human development.</li> </ul> </li> </ul> <p>Related activities: P04: DEVELOPMENT MODELS</p> <p>Specific objectives:</p> <p>For students to:</p> <ul style="list-style-type: none"> <li>- Understand development as a multifaceted phenomenon comprising social, cultural, political, economic, institutional, technological, environmental and ecological aspects.</li> <li>- Understand the interdependence between these dimensions and their conditioning factors.</li> <li>- Understand the role of technology, engineering and cooperation in global change.</li> <li>- Understand the concept of human development and well-being.</li> <li>- Understand the main proposals of human development models: political ecology proposals, the model of human-scale development, and the human development of the UNDP.</li> </ul>	

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<p><b>TOPIC 6: POLITICS AND SUSTAINABILITY</b></p>	<p>Learning time: 10h Theory classes: 1h Practical classes: 2h Self study : 7h</p>
<p>Description: 6.1. Democracy. Citizen participation. 6.2. Institutions of global governance. International programmes. 6.3. Globalism. New proposals.</p> <p>Related activities: P06. The economy of common well</p> <p>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.</p>	
<p><b>TOPIC 7: ENVIRONMENTAL IMPACTS AND MANAGEMENT TOOLS</b></p>	<p>Learning time: 22h Theory classes: 2h Practical classes: 2h Self study : 18h</p>
<p>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.</p> <p>Related activities: P12: ENVIRONMENTAL MANAGEMENT TOOLS</p> <p>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.</p>	

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<p>TOPIC 8: WATER MANAGEMENT</p>	<p>Learning time: 9h Theory classes: 1h Practical classes: 2h Self study : 6h</p>
<p>Description: 8.1. Water resources. 8.2. Uses of water. Sources of pollution. 8.3. Sustainability indicators: environmental and socioeconomic. 8.4. Overview of the main water-treatment technologies. Water treatment. Water softening. Water purification. 8.5. Demand management.</p> <p>Related activities: P07: WATER MANAGEMENT</p> <p>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.</p>	
<p>TOPIC 9: WASTE MANAGEMENT</p>	<p>Learning time: 9h Theory classes: 1h Practical classes: 2h Self study : 6h</p>
<p>Description: 9.1. Generation of waste (municipal, industrial). 9.2. Management and technology for assessing/processing municipal waste. 9.3. Management and technology for assessing/processing industrial waste.</p> <p>Related activities: P10: WASTE MANAGEMENT</p> <p>Specific objectives: For students to: Identify the main management models and technologies for assessing/treating municipal and industrial waste.</p>	



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<p>TOPIC 10: ENERGY</p>	<p>Learning time: 9h Theory classes: 1h Practical classes: 2h Self study : 6h</p>
<p>Description:</p> <ul style="list-style-type: none"> <li>10.1. The concept of energy.</li> <li>10.2. The dispersion of energy.</li> <li>10.3. The different forms of energy.</li> <li>10.4. Trends in energy use.</li> <li>10.5. Implications: ecological footprint and peak oil.</li> <li>10.6. Alternative energy sources.</li> <li>10.6.1. The energy debate.</li> <li>10.6.2. Efficiency and renewable energy sources.</li> </ul> <p>Related activities: P08: ENERGY</p> <p>Specific objectives: For students to:</p> <ul style="list-style-type: none"> <li>- Identify problems associated with energy consumption as relates to emissions and reserves.</li> <li>- Identify improvement proposals related to renewable energy sources and energy efficiency.</li> </ul>	
<p>TOPIC 11: AIR POLLUTION</p>	<p>Learning time: 27h Theory classes: 2h Practical classes: 6h Self study : 19h</p>
<p>Description:</p> <ul style="list-style-type: none"> <li>11.1. Atmosphere.</li> <li>11.2. Main air pollutants and emission sources.</li> <li>11.3. The effects of pollution.</li> <li>11.4. Air-quality indicators (ICQA).</li> <li>11.5. Description of the main elimination-treatment technologies and gaseous pollutants.</li> </ul> <p>Related activities: P09: Gas emissions. P11: Pollution problem</p> <p>Specific objectives: For students to:</p> <ul style="list-style-type: none"> <li>- Identify the main air pollutants and emission sources.</li> <li>- Determine air-quality indices.</li> <li>- Describe the main treatment technologies for eliminating particles and gaseous pollutants.</li> </ul>	

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### 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.

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### Bibliography

#### Basic:

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- García Rodríguez, A. La contaminación acústica: fuentes, evaluación, efectos y control. Madrid: Sociedad Española de Acústica, 2006. ISBN 8487985106.
- Masters, Gilbert M. Introducción a la ingeniería medioambiental. Madrid: Prentice-Hall, 2008. ISBN 9788483224441.
- Wark, Kenneth. Contaminación del aire: origen y control. México: Limusa, 1990. ISBN 9681819543.
- Masoliver, Dolors. Guía práctica para la implantación de un sistema de gestión ambiental. Barcelona: Departament de Medi Ambient, 2000. ISBN 8439353057.
- Max-Neef, Manfred A. Desarrollo a escala humana: conceptos, aplicaciones y algunas reflexiones. Montevideo: Nordan Comunidad, 1993. ISBN 9974420059.
- Morin, Edgar. "Complejidad restringida, complejidad general". Sostenible? [on line]. Núm. 9 (2007), p. 23-49 [Consultation: 10/07/2017]. Available on: <<http://hdl.handle.net/2099/3883>>.
- Novo, María. El desarrollo sostenible: su dimensión ambiental y educativa. Madrid: Pearson Educación, 2006. ISBN 9788483223550.
- Orozco, Carmen. Contaminación ambiental: una visión desde la química. Madrid: International Thomson, 2003. ISBN 8497321782.
- Sawyer, Clair N. Química para ingeniería ambiental. 4a ed. Bogotá: McGraw-Hill, 2001. ISBN 9584101641.
- Tchobanoglous, George. Gestión integral de residuos sólidos. Madrid: McGraw-Hill, 1994. ISBN 8448118308.
- Xercavins, J. [et al.]. Desarrollo sostenible [on line]. Barcelona: Edicions UPC, 2005 [Consultation: 08/01/2016]. Available on: <<http://hdl.handle.net/2099.3/36752>>. ISBN 8483018055.

#### Complementary:

- Campos electromagnéticos, salud pública y laboral: ponencias y materiales de las Jornadas sobre Contaminación Electromagnética y Salud Pública celebradas los 10 y 11 de diciembre de 2002 en Madrid. Madrid: Unión Sindical de Madrid Región, 2003. ISBN 8497210786.
- Fullana i Palmer, P. Análisis del ciclo de vida. Barcelona: Rubes, 1997. ISBN 8449700701.
- Rieradevall, Joan. Ecodisseny i ecoproductes. Barcelona: Departament de Medi Ambient, 1999. ISBN 8439349920.
- Stahel, Andri. "Las necesidades humanas y la (re)producción de la pobreza por el desarrollo económico moderno". Ecología política: cuadernos de debate internacional. Núm. 23, p. 141-151.
- Stahel, A.; Cano, M.; Cendra, J. "Oikonomía vs. crematística: base de las contradicciones del desarrollo moderno". Sostenible? [on line]. Núm. 7 (2005), p. 47-71 [Consultation: 10/07/2017]. Available on: <<http://hdl.handle.net/2099/1805>>.
- Stahel, A.; Cano, M.; Cendra, J. "Desarrollos sostenibles". Sostenible? [on line]. Núm. 7 (2005), p. 73-91 [Consultation: 10/07/2017]. Available on: <<http://hdl.handle.net/2099/1806>>.
- Fullana i Palmer, P. Análisis del ciclo de vida. Barcelona: Rubes, 1997. ISBN 8449700701.
- Programa de las Naciones Unidas para el Desarrollo. Informe sobre desarrollo humano 2006: más allá de la escasez: poder, pobreza y la crisis mundial del agua. Madrid: CIDEAL, 2006.
- Water in a changing world. Paris: UNESCO, 2009. ISBN 9789231040955.

#### Others resources:

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