2SC7310 – Circular economy and industrial ecology methods

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Department: DÉPARTEMENT GÉNIE INDUSTRIEL ET OPÉRATIONS
Language of instruction: FRANCAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 60
On-site hours (HPE): 34,50

Description

According to ADEME (French environmental protection agency), Circular Economy aims at shifting the current paradigm based on linear economy, by limiting the waste of resources and environmental impacts, and by increasing the efficiency at all stages of products economy. It is composed of 7 pillars: sustainable procurement, eco-design, industrial and territorial ecology, functional economy, responsible consumption, longer duration of use, recycling and waste recovery.

Industrial Ecology is an approach whose objective is to limit the impacts of industry on the environment. It aims at considering an industrial system as a whole to identify, model and optimize material and energy flows, as well as associated environmental impacts. It aims at reproducing a natural system in the human activities, where all material and energy flows are reused, where the notion of waste does not exist anymore. All economic sectors are concerned.

The course's objective is to cover the different dimensions of circular economy to provide to the students a global vision of the field. Then the focus will be made on the operational industrial ecology tools, which students will learn to manipulate (MFA (Material Flow Analysis, tool to map material and energy flows) and LCA (Life-Cycle Assessment, tool to calculate environmental impacts) software) to drive industrial ecology projects. These tools will be directly used for the project of the engineering challenge term.

Quarter number

ST7

Prerequisites (in terms of CS courses)

None

Syllabus
The course is structured into 11 3-hours sessions.

1. Introduction to Circular Economy and environmental impacts (Yann Leroy and/or François Cluzel)

A. The Pillars of Circular Economy
The sessions 2-6 are built on the following format: lecture and workshop on an industrial case study. These sessions go through the 7 pillars of Circular Economy according to the ADEME's definition.
2. Product End-of-life (Yann Leroy and/or François Cluzel)
3. Ecodesign, extension of product lifespan and responsible consumption (Yann Leroy and/or François Cluzel)
4. Sustainable procurement (Yann Leroy and/or François Cluzel)
5. Functional economy and responsible consumption (ATEMIS)
6. Industrial and Territorial Ecology (Yann Leroy and/or François Cluzel and/or Andreas Hein)

B. Methods and tools for Industrial Ecology
The sessions 7-11 (Yann Leroy and/or François Cluzel) are dedicated to Material Flow Analysis (MFA), Life Cycle Assessment (LCA) and Circularity and Sustainability Indicators (lectures and workshops). These three approaches will be applied on a case study in group.

12. Final exam : duration 1h30

Class components (lecture, labs, etc.)
According to specific needs, the sessions will alternate lectures and tutorials on industrial case (case study and or serious games), and tutorials on MFA and LCA professional software (used during the project of the Engineering Challenge Term). Some sessions may be organized as flipped classrooms.

Grading
Final written exam on sessions 1 to 6 (50%) + evaluation of tutorials (per group) for sessions 7-11 (50%)

Course support, bibliography

- Adoue, C., 2007. Mettre en œuvre l'écologie industrielle. PPUR, Lausanne.
- Buclet, N., Barles, S., 2011. Écologie industrielle et territoriale : Stratégies locales pour un développement durable. Presses Universitaires du Septentrion, Villeneuve d'Ascq, France.
- Erkman, S., 2004. Vers une écologie industrielle, 2e éd. ed. Charles Léopold Mayer, Paris.

- Hawken, P., Lovins, A., Lovins, L.H., 1998. Natural Capitalism: Creating the Next Industrial Revolution, 1st edition. ed. US Green Building Council, Boston.

Resources

Teachers: François Cluzel, Yann Leroy (researchers at the Industrial Engineering Research Department) and some other researchers, PhD students or external speakers

Software: Life-Cycle Assessment (OpenLCA) and Material Flow Analysis (Stan)

Learning outcomes covered on the course

- Be aware of major environmental stakes
- Know the 7 pillars of circular economy
- Master the main industrial ecology tools: Material Flow Analysis, Life-Cycle Assessment, Circularity and Sustainability Indicators
- Be able to model and simulate an industrial system in a circular economy perspective
- Be able to optimize an industrial system in a circular economy perspective

Description of the skills acquired at the end of the course

- C1 Analyse, design and implement complex systems made up of scientific, technological, social and economic dimensionsC1.1 Examine problems in their entirety and beyond their immediate parameters. Identify, formulate and analyse the scientific, economic and human dimensions of a problem
    - C1.2 Develop and use appropriate models, choosing the correct modelling scale and simplifying assumptions when addressing a problem
    - C1.3 Apply problem-solving through approximation, simulation and experimentation. / Solve problems using approximation, simulation and experimentation
    - C1.5 Bring together broad scientific and technical concepts in a core structure contained within the framework of an interdisciplinary approach
- C2 Acquire and develop broad skills in a scientific or academic field and applied professional areas
    - C2.1 Thoroughly master a domain or discipline based on the fundamental sciences or the engineering sciences

- C2.5 Master the skillset of a core profession within the engineering sciences (at junior level)

- C6 Advance and innovate in the digital world
  - C6.2 Engage in design thinking using classic and agile conception and prototyping tools (CAD, 3D printing etc.)
  - C6.5 Operate all types of data, structured or unstructured, including big data.
- C9 Think and act as an accountable ethical professional
  - C9.1 Understand and analyse the consequences of one's choices and actions.
  - C9.2 Identify, within a given structure, the scope of liability as well as socio-ethical and environmental responsibilities.
  - C9.4 Demonstrate rigour and critical thinking in approaching problems from all angles, be they scientific, social or economic.