# UNIVERSITÀ DEGLI STUDI DI PALERMO

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| **DEPARTMENT** | Ingegneria | | |
| **ACADEMIC YEAR** | 2019/2020 | | |
| **MASTER'S DEGREE (MSC)** | ENGINEERING AND INNOVATIVE TECHNOLOGIES FOR THE ENVIRONMENT | | |
| **INTEGRATED COURSE** | ENERGY EFFICIENCY AND SYSTEM AND PROCESS ECO-DESIGN - INTEGRATED COURSE | | |
| **CODE** | 20552 | | |
| **MODULES** | Yes | | |
| **NUMBER OF MODULES** | 2 | | |
| **SCIENTIFIC SECTOR(S)** | ING-IND/11 | | |
| **HEAD PROFESSOR(S)** | CELLURA MAURIZIO | Professore Ordinario | Univ. di PALERMO |
| **OTHER PROFESSOR(S)** | SCACCIANOCE GIANLUCA | Professore Associato | Univ. di PALERMO |
| | CELLURA MAURIZIO | Professore Ordinario | Univ. di PALERMO |
| **CREDITS** | 12 | | |
| **PROPAEDEUTICAL SUBJECTS** | | | |
| **MUTUALIZATION** | | | |
| **YEAR** | 1 | | |
| **TERM (SEMESTER)** | 1° semester | | |
| **ATTENDANCE** | Not mandatory | | |
| **EVALUATION** | Out of 30 | | |
| **TEACHER OFFICE HOURS** | **CELLURA MAURIZIO**<br>Wednesday 10:00 13:00 Stanza Prof. Cellura<br>**SCACCIANOCE GIANLUCA**<br>Monday 12:00 14:00 Stanza docente, 2° piano dell'edificio 9 (lato Fisica Tecnica), Dipartimento di Ingegneria | | |

**DOCENTE:** Prof. MAURIZIO CELLURA

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| **PREREQUISITES** | Good knowledge of mathematics. |
| **LEARNING OUTCOMES** | Knowledge and understanding skills:<br>The student will gain knowledge and understanding on techniques for the diagnostic and analysis for improving the energy and environmental efficiency of processes and systems, in order to reduce their impact on the environment, according with specific regulations, mainly related to the energy management systems.<br><br>Applications of the understanding and knowledge gained: The student will know the main concepts of the LCA methodology, to identify the main solutions for the improvement of the energy and environmental performance (eco-design) of products, services and organizations, to know the main typologies of products environmental labels, to know the tools for developing ISO 50001. In addition, the student will acquire the ability to perform a correct energy/environmental analysis of industrial systems and processes, identifying the best available technologies (BAT) for sustainable process management, singling out more suitable public funding.<br><br>Autonomy in critical judgment: The course will allow the student to comprehend the main problems to face when assessing the energy and environmental performance of processes and systems as well as of products, services and organizations, in order to suggest best energy-environmental efficient eco-design solutions and, therefore, to assess their effectiveness. Furthermore, the student will be able to understand the basics of the environmental label systems, and the energy analysis of industrial processes and systems.<br><br>Communication skills: The lectures and the final examination aim at the development of the students' communication skills towards all the private and institutional stakeholders.<br><br>Learning objectives: The student will gain knowledge in the technical-engineering field and will be able to apply the skills acquired during the classes. Furthermore, the student will gain terminologies, languages, mathematical and descriptive methods that characterize the LCA methodology, the eco-design, environmental label systems, the energy analysis of industrial processes and systems. |
| **ASSESSMENT METHODS** | The exam is based on a single oral test, aimed to verify the level of knowledge and skills expected for the course; the final grade ranges from 0 to 30. The maximum grade is given if the students show mastery of the following three skills during the exams: critical and interdisciplinary judgement applied to the topics of the course; well-developed skills in the understanding of the impacts of the topics of the course in the sector considered, a well-developed ability to discuss ideas and innovative solutions in the context of the discipline.<br>During the exam, the student will discuss the topics studied during the course. The questions asked to students are either open or semi-structured and tailored to test the learning results expected. The minimum number of oral questions during the exam is three. They aim at verifying: a) learning, b) elaboration capabilities, c) verbal capabilities.. More in detail:<br>a) The learning verification will be performed through the analysis of the capability of the student to perform connections between the theoretical and practical contents of the course,<br>b) About the elaboration capabilities of the students, the following skills will be evaluated:<br>b1) perform personal evaluations about the contents of the course;<br>b2) understanding the applications or the implications of the contents in the context of the topics of the course;<br>b3) allocate the contents of the course in the professional and technological reference context;<br>b4) capability of reading and understanding complex systems.<br>c) In the field of the verbal skills, the student will receive the lowest grade if he/she shows a language skill adequate to the professional context but still not optimal, while the maximum grade will be assigned to the students having a complete understanding and mastery of the technical language skills required.<br>Grades rating Excellent 30 - 30 cum laude: excellent knowledge of the topics, excellent language skills, the student is able to apply knowledge to solve problems.<br>Very good 26-29: good knowledge of the topics of the course, full mastery of language, the student is able to apply knowledge to solve the proposed problems.<br>Good 24-25: basic knowledge of the main topics, basic technical language skills, limited ability to independently apply knowledge to the solution of problems.<br>Sufficient 21-23: the student does not have full capabilities but has the knowledge, sufficient technical language skills, poor ability to independently apply knowledge to problem. |

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| | Barely sufficient 18-20: the student has minimal knowledge of the course topics and minimal technical language, very little or no ability to independently apply the knowledge.<br>Insufficient: the student does not have an acceptable knowledge of the course topics. |
| **TEACHING METHODS** | Lectures and coursework. |

## MODULE
## ENERGY EFFICIENCY

*Prof. GIANLUCA SCACCIANOCE*

**SUGGESTED BIBLIOGRAPHY**

Frank Kreith, "Principles of sustainable energy systems", CRC
F. Calise, M. Dentice D'Accadia, L. Vanoli, R. Vanoli, "Fondamenti di analisi exergetica", Giapeto
Appunti e dispense fornite dal Docente

Altri testi di utile consultazione:
A. Bejan, Entropy Generation Minimization, wiley & sons
F. Zhu, Energy And Process Optimization for the Process Industries, Wiley & Sons, 2014
F. C. Knopf, Modeling, Analysis and Optimization of Process and Energy Systems, Wiley & Sons, 2012

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| **AMBIT** | 20937-Attività formative affini o integrative |
| **INDIVIDUAL STUDY (Hrs)** | 96 |
| **COURSE ACTIVITY (Hrs)** | 54 |

**EDUCATIONAL OBJECTIVES OF THE MODULE**

The course aims to provide concepts that allow students to tackle problems related to improving the energy/environmental performance of systems and processes with particular reference to the industrial and and service sector. Specifically: pertinent regulations; feasibility criteria for possible actions from the technological, economic, energy and environmental points of view; Investigation methods for the energy analysis of systems and processes; some possible available technologies.

## SYLLABUS

| Hrs | Frontal teaching |
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| 1 | Course overview |
| 4 | Observations about regulations on improvement of energy efficiency of processes |
| 6 | Criteria for the feasibility: Technological sustainability; finance; Tax concessions; Project finance; White and Green certificates |
| 10 | Energy-aware performance analysis methodologies: Energy costs; Exergetic analysis; Energy audit; Elements of mass and energy flow analysis; Elements of optimization methods |
| 7 | Applications (such as case studies): Sizing of a photovoltaic system; Sizing of a solar thermal system; Sizing of a cogeneration plant; Improvement of energy/environmental performance of plant components; Choice of the best gas and electricity supply contract; BAP, BAT, Energy Intelligence for system control, EMS |

| Hrs | Practice |
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| 4 | Exercise on the assessment of the economic performance of an action |
| 8 | Exercises on energy-aware performance analysis methodologies |
| 12 | Exercises on application of available technologies |

## MODULE
## SYSTEM AND PROCESS ECO-DESIGN

*Prof. MAURIZIO CELLURA*

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| **SUGGESTED BIBLIOGRAPHY** | |
| Materiali didattico fornito durante le lezioni | |
| **AMBIT** | 20937-Attività formative affini o integrative |
| **INDIVIDUAL STUDY (Hrs)** | 96 |
| **COURSE ACTIVITY (Hrs)** | 54 |
| **EDUCATIONAL OBJECTIVES OF THE MODULE** | |
| The course aims at giving the necessary knowledge to find solutions to improve the energy and environmental performance (eco-design) of products, services and organizations, to apply the Life Cycle Assessment methodology to products and services, in order to obtain product environmental labels, to apply the energy analysis to industrial processes and systems. | |

## SYLLABUS

| Hrs | Frontal teaching |
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| 1 | Introduction to the course |
| 3 | Introduction to the Life Cycle Assessment (LCA). Methodological principles and basic features of LCA. The steps of LCA. The international standards of ISO 14040 series. |
| 10 | The steps of LCA |
| 6 | Definition of eco-design criteria |
| 4 | Environmental labels: Ecolabel, Environmental product declaration, Product Environmental Footprint |
| 10 | The ISO 50001 on the energy management systems |

| Hrs | Practice |
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| 26 | Exercises on the application of the LCA methodology, on the definition of eco-design criteria, on the application of ISO 50001. |