UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2020/2021
MASTER'S DEGREE (MSC)	ENERGETIC AND NUCLEAR ENGINEERING
SUBJECT	ENERGY SYSTEMS LCA
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50367-Ingegneria energetica e nucleare
CODE	18044
SCIENTIFIC SECTOR(S)	ING-IND/11
HEAD PROFESSOR(S)	LONGO SONIA Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**LONGO SONIA** Thursday 10:00 12:00 Dipartimento di Ingegneria, Viale delle Scienze Ed.9, 1° piano, stanza S09P1021

DOCENTE: Prof.ssa SONIA LONGO

PREREQUISITES	Good knowledge of of mathematics and applied physics.
LEARNING OUTCOMES	Knowledge and understanding skills: The student will gain knowledge and understanding on the main European directives on the energy and environmental performance of products and systems as well as the standards on Life Cycle Assessment (LCA). Furthermore, the student will gain knowledge and understanding on the application of the LCA methodology to energy technologies and energy systems, with particular attention to mass and energy balances, and energy and environmental impacts of the examined technologies and systems. Applications of the understanding and knowledge gained: The student will be able to perform complete LCAs of energy technologies and energy systems, to calculate their carbon footprint and product environmental footprint, and to define eco-design solutions for reducing their energy and environmental impacts. The student will gain an understanding of the LCA calculation methodologies and will have experience of the most relevant LCA software and databases, and their theoretical fundamentals. Autonomy in critical judgment: The course will allow the student to comprehend the main problems to face when assessing thr energy and environmental performance of energy technologies and energy systems, to suggest eco-design solutions and to assess their effectiveness. Furthermore, students will be able to understand and critically analyze the LCA results. Communication skills: The lectures and the final examination features aim at the development of the students' communication skills towards all the private and institutional stakeholders. Learning objectives: The student will gain knowledge in the technical-engineering field and will be able to apply the skills acquired during previous classes. Furthermore, the student will gain terminologies, languages, mathematical and descriptive methods that characterize the LCA, the carbon footprint and the product environmental footprint.
ASSESSMENT METHODS	The exam is based on a single oral test, aimed to verify the level of knowledge and competencies expected for the course, the final grade ranges from 0 to 30. The maximum grade is given if the exam clarifies that the students master the following three skills: critical and interdisciplinary judgement in the topics of the course, understanding of the impacts of the topics of the course in the building physics and LCA sector, capability to elaborate ideas and discuss innovative solutions in the field of the LCA. The student will develop solutions of LCA exercises developed during the course. Moreover, he will discuss the topics studied during the course. The questions asked to the students, either open or semi-structured and tailored to test the learning results expected, will verify a) learning verification, b) elaboration capabilities, c) verbal capabilities. The minimum number or oral questions during the exam is 3. More in detail: 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, b) About the elaboration capabilities of the students, the following skills will be evaluated: b1) performing personal evaluations about the contents of the course; b2) understanding the applications or the implications of the contents of the course; b3) allocate the contents of the course in the professional and technological reference context; b4) capability of reading and understanding complex systems and simulations. 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. 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. 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. Good 24-25: basic knowledge of the main topics, basic technical language skills, limited ability to independently apply knowledge to the solution of problems. 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. 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. Insufficient: the student does not have an acceptable knowledge of the course topics.
EDUCATIONAL OBJECTIVES	The course aims at giving the necessary knowledge for the application of Life Cycle Assessment methodology to energy systems, for the calculation of their carbon and product environmental footprint, and for the definition of eco-design solutions.
TEACHING METHODS	Lectures (including integrated examples and modeling sessions), coursework
SUGGESTED BIBLIOGRAPHY	1) Standard UNI EN 14040 e UNI EN 14044 2) ILCD Handbook – International Reference Life Cycle Data System, available on http://eplca.jrc.ec.europa.eu/ 3) Guidance for the implementation of the EU Product Environmental Footprint (PEF), available on http://ec.europa.eu/environment/eussd/smgp/productfootprint.htm 4) Lecture notes 5) Life Cycle Assessment applicata all'edificio Metodologia e casi di studio sul sistema fabbricato-impianto, M. Cellura (coordinatore), Editoriale Delfino Collana AICARR, 2017, ISBN: 978-88-97323-65-5

SYLLABUS

Hrs	Frontal teaching
1	Introduction to the course
2	Circular economy
2	Introduction to the Life Cycle Assessment (LCA). Methodological principles and basic features of LCA. The steps of LCA
1	The standards for LCA. The international standards of ISO 14040 series
3	The first step of LCA: the goal and scope definition. Functional unit, system boundaries, impact categories. Allocation and cut-off rules. The report of a LCA study
4	Data collection and data quality in LCA. Software and databases for LCA
6	Life Cycle Inventory (LCI): analysis of process-based and matrix methods
5	Environmental indicators and indices. Life Cycle Impact Assessment (LCIA): LCIA steps and impact assessment methods. Carbon footprint and product environmental footprint calculation
6	Interpretation step: analysis of the results and dominance analysis. Uncertainty and sensitivity analysis. Definition of eco-design criteria
3	Environmental labels
3	Case studies on LCA applied to energy technologies and systems
2	Hybrid models for the assessment of the energy and environmental impacts

Hrs	Practice
16	Exercises on the different steps of the LCA. Application of the LCA methodology to an energy system. Use of software and databases for LCA