UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria		
ACADEMIC YEAR	2023/2024		
MASTER'S DEGREE (MSC)	MANAGEMENT ENGINEERING		
INTEGRATED COURSE	SUSTAINABILITY AND SOCIAL IMPACT - INTEGRATED COURSE		
CODE	22246		
MODULES	Yes		
NUMBER OF MODULES	3		
SCIENTIFIC SECTOR(S)	ING-IND/35, ING-IND/17, ING-IND/16		
HEAD PROFESSOR(S)	INGARAO GIUSEPPE	Professore Associato	Univ. di PALERMO
OTHER PROFESSOR(S)	MAZZOLA ERICA	Professore Associato	Univ. di PALERMO
	INGARAO GIUSEPPE	Professore Associato	Univ. di PALERMO
	AIELLO GIUSEPPE	Professore Associato	Univ. di PALERMO
CREDITS	18		
PROPAEDEUTICAL SUBJECTS			
MUTUALIZATION			
YEAR	2		
TERM (SEMESTER)	Annual		
ATTENDANCE	Not mandatory		
EVALUATION	Out of 30		
TEACHER OFFICE HOURS	**AIELLO GIUSEPPE**		
	Monday 10:00 13:00 Dicgim Ed.9 - stanza personale		
	INGARAO GIUSEPPE		
	Monday 12:00 16:00 Dipartimento di Ingegneria, Universita degli Studi di Palermo - Viale delle Scienze - 90128 PALERMO (ITALY)		
	Thursday 14:00 18:00 Dipartimento di Ingegneria, Universita degli Studi di Palermo - Viale delle Scienze - 90128 PALERMO (ITALY)		
	MAZZOLA ERICA		
	Friday 09:00 12:00		

PREREQUISITES	PREREQUISITE (Circular Economy Business Models Module) The course has no specific pre-requisites.
	PREREQUISITE (Sustainable Manufacturing Module) Knowledge of manufacturing processes; specifically, expertise concerning metal shaping processes is highly recommended. Mechanical as well technological properties of engineering materials
LEARNING OUTCOMES	LEARNING OUTCOMES (Circular Economy Business Models Module)
	Knowledge and understanding:
	At the end of the course, the student must be able to understand how an organization can plan and organize its strategy and operations toward sustainability. The student will develop a clear understanding of sustainability management concepts and will be able to develop knowledge of the various tasks, methods and approaches to manage sustainability transformation of organizations. Moreover, the student will learn the principles, approaches and standard for sustainability disclosure and reporting and will understand the principles of the circular economy and new business models oriented to optimize environmental performance with a view to sustainability.
	Comprehension and ability to apply knowledge
	Upon completing the study program, the student will learn to use a multidisciplinary approach and apply their knowledge to reach solutions based on sustainability. The students will develop a systemic way of thinking, which supports her/his understanding of complex situations related to sustainability issues and capacity to develop problem-solving skills. The student will be able to use methods and tools to develop a strategic sustainability plan and to design a sustainability report. Upon completing the study program, students will learn how to effectively communicate and work, as an expert in sustainability issues. Making judgments Upon completing the study program, students will be able to present an informed scientific opinion in the public debate concerning the sustainability management. Students will acquire the ability to gather and interpret information and data from different sources, in order to make judgements in an independent way. Moreover, students will be able to prepare original research supported by relevant bibliography and data analysis and debate different perspectives to address sustainability issues.
	Communication skills Students will be able to develop the ability to communicate in written form through completing the case studies discussions, and in oral form through the final presentation of the project work and the class debate. Moreover, the students will be able to use the notions and the communication of sustainability management.
	Learning ability
	Upon completing the study program, students will be able to build an analytic toolbox from the analysis of complex economic processes which involves the application of sustainability, and to solve problems in dynamics settings and develop critical positions.
	LEARNING OUTCOMES (Sustainable Manufacturing Module) Knowledge and comprehension skills. The course aims at providing skills concerning products environmental impact analysis. The whole product life cycle as well as the inventory techniques for each phase life will be analyzed. The student will be able to identify the dominant phase as well as to propose new strategies to minimize the environmental impact of a given product. The student will be an expert in energy and resource efficiency in product manufacturing and in Life Cycle engineering (LCE) techniques. The students will be able to developed life cycle comparative analysis under both economic and ecological design objectives. Ability to apply the acquired knowledge. The students will apply the learned Life Cycle Engineering methodologies to several case studies. Specifically, during practical classes and project work development the students can apply the acquired knowledge to real case studies. Also during oral examination two extra questions will be asked to foster the student reasoning and to test his/her problem solving skills. Independent thinking skills. The students, by the end of teh course, will have learned Life cycle based

methodologies aimed at analyzing the environmental impact of a product/ process. The students, will be able to both identify the main issues and to propose innovative strategies to minimize the environmental impact of a given product/process.

Communication skills

The students will be able to proper communicate the acquired content, specifically they will be able to take part to technical discussions concerning Life Cycle Engineering. Communications skills will be developed by case studies analysis developed within the practical classes as well as by the project work presentation.

Learning skills

Students should be able to independently implement economic and ecological analyses of an assigned case study. Moreover they have to prove they can propose new design strategies to improve the ecological performance of a product/process.

REVERSE LOGISTICS AND SMART WASTE MANAGEMENT MODULE
LEARNING OUTCOMES
Knowledge and understanding:

The students will develop knowledge and clear understanding of the key issues related to the field of the circular economy. Students will be able to understand circular economy models; to have an overview of the main dynamics related to the circular economy issues; define new business ideas of circular systems.

Comprehension and ability to apply knowledge

Upon completing the study program, students will learn to use a multidisciplinary approach and apply their knowledge to reach solutions based on circular economy. The students will be develop a systemic way of thinking, which supports their understanding of complex situations and capacity to develop problem-solving skills. Upon completing the study program, students will learn how to effectively communicate and work, as an expert in circular economy issues.

Making judgments

Upon completing the study program, students will be able to present an informed scientific opinion in the public debate concerning the circular economy. Students will acquire the ability to gather and interpret information and data from different sources, in order to make judgements in an independent way. Moreover, students will be able to prepare original research supported by relevant bibliography and data analysis and debate different perspectives to address circular economy issues.

Communication skills

Students will be able to develop the ability to communicate in written form through completing the case studies discussions, and in oral form through the final presentation of the project work and the class debate. Moreover, the students will be able to use the notions and the communication of circular economy.

Learning ability

Upon completing the study program, students will be able to build an analytic toolbox from the analysis of complex economic processes which involves the application of new circular models, and to solve problems in dynamics settings and develop critical positions.

ASSESSMENT METHODS	ASSESSMENT METHODS (Circular Economy Business Models Module)
	Evaluation of student performance in this course will be based on group project, active learning activities and oral exam. Distribution of grades is based on the following percentages:
	50%: Project work (teamwork)
	20%: Active learning activity (teamwork)
	30%: Oral exam
	The assessment of knowledge, competences, and applicative capabilities consists of a project group related to the sustainability reporting. Students need to select a business organization within an industry of their choice and define the guide lines for developing a sustainability report.
	In addition, since the best way to learn is by teaching, the active learning activities of this course are designed to do that. Briefly, students will pick a topic related to sustainability management and will then conduct some background research on it, and share their findings with the class conducting a real lecture of 10-15 min or making a short video of 4-5 minutes.
	Finally, the oral exam will count for 30% of the total grade.
	The student assessment is as follows:
	Excellent 30-30 cum laude. The student shows excellent knowledge of the topics of the course, excellent language and communication skills, excellent ability to analyze the issues related to the core topics of sustainability, excellent ability to understand real arguments in the settings of the course, excellent ability to connect the topics among them and to develop critical analysis in the field of sustainability. Cum Laude grade is assigned to those students who show a brilliant and well above average ability to sustain a discussion on the core

topics of sustainability.

Very good 26-29. The student shows very good knowledge of the topics of the course, very good language and communication skills, very good ability to analyze the issues related to the core topics of sustainability, very good ability to understand real arguments in the settings of the course, very good ability to connect the topics among them and to develop critical analysis in the field of sustainability.

Good 24-25. The student shows good knowledge of the topics of the course, good language and communication skills, good ability to analyze the issues related to the core topics of circular economy, good ability to understand real arguments in the settings of the course, good ability to connect the topics among them and to develop critical analysis in the field of sustainability.

Satisfactory 21-23. The student shows satisfactory knowledge of the topics of the course, satisfactory language and communication skills, satisfactory ability to analyze the issues related to the core topics of sustainability, satisfactory ability to understand real arguments in the settings of the course, satisfactory ability to connect the topics among them and to develop critical analysis in the field of sustainability.

Sufficient18-20. The student shows sufficient knowledge of the topics of the course, sufficient language and communication skills, sufficient ability to analyze the issues related to the core topics of sustainability. The student does not show the ability to understand real arguments in the settings of the course, the ability to connect the topics among them and to develop critical analysis in the field of sustainability.

Insufficient. The student show he/she has not reached the minimum knowledge of the topics of the course and shows not satisfactory language and communication skills. The student also shows he/she has not reached a sufficient ability to analyze the issues related to the core topics of sustainability. The final grade is the weighted average of the assessments obtained in the three evaluations.

ASSESSMENT METHODS (Sustainable Manufacturing Module)
The evaluation procedure consists of two parts. The first part focuses on a project work to be developed throughout the course. The second part is a more conventional oral examination. As far as the project work is concerned, it will be organized in teams of 3/4 students. The students will be assigned an overall topic and they will have to independently analyze and properly address their research activities. The project delivery consists of a PowerPoint presentation (15 minutes for each student). After presentation a brief discussion will take place, the teacher will ask the student some questions to analyze the acquired skills by means of project work development. Such examination aims at evaluating the personal reinterpretation level as well as the ability to deepen an assigned topic. By PowerPoint presentation the teacher can also evaluate the students communication skills.

After the project work discussion the teacher will assign an individual mark (on a scale of 30) to each student. As far as the second step of the evaluation procedure is concerned, an oral examination will take place. During the exam the teacher will ask at least 4 questions to cover all the main topics dealt with within the course. Subsequently,two more questions will be asked to evaluate both the level of personal reinterpretation of the learned contents as well as the ability to apply the acquired knowledge to real case studies. Such two extra questions will be properly structured and will be also less specific to foster the student reasoning and to test his/her problem solving skills. Students will receive a mark for the oral presentation. The student will be positively evaluated only if they prove to have at least an acceptable knowledge of the topics provided during the course.

The mark will rise as the level of knowledge, the ability of personal reinterpretation of as well as the aptitude to apply acquired knowledge to real case studies improve. The final mark is obtained by carrying out the arithmetic mean between the project work and the oral examination marks.

The final mark is carried out according to the following evaluation grid:
Excellent 30-30 cum laude. The student shows an excellent understanding of the studied topics, excellent properties of language, excellent ability to frame real arguments in the studied methodologies, excellent ability to link the studied topics with each other, The students is able to develop Life Cycle Engineering analyses identifying issues and solution of several case studies. The student during the course developed autonomy and good interpersonal skills and leadership.

Very good 26-29. The student shows an excellent understanding of the studied topics, excellent properties of language, good ability to frame real arguments in the studied methodologies, good ability to link the studied topics with each other.The students is able to develop Life Cycle Engineering analyses identifying issues and solution of several case studies. The student during the

course developed autonomy and good interpersonal skills and leadership.
Good 24-25. The student shows a good understanding of the studied topics, good properties of language, satisfactory ability to frame real arguments in the studied methodologies, satisfactory ability to link the studied topics with each other. The students is able to develop Life Cycle Engineering analyses identifying issues and solution of several case studies. The student during the course improved its autonomy and its interpersonal skills and leadership.
Satisfactory 21-23. The student shows a satisfactory understanding of the studied topics, satisfactory properties of language, scarce ability to frame real arguments in the studied methodologies, scarce ability to link the studied topics with each other. The students is not able to develop Life Cycle Engineering analyses identifying issues and solution of several case studies. The student during the course did not improve its autonomy and its interpersonal skills and leadership.
Sufficient 18-20. The student shows a sufficient understanding of the studied topics, sufficient properties of language. The student shows no ability to frame real arguments in the studied methodologies, and no ability to link the studied topics with each other The students is not able to develop Life Cycle Engineering analyses identifying issues and solution of several case studies.The student during the course did not improve its autonomy and its interpersonal skills and leadership.
Not sufficient. The student highlights of not having the minimum knowledge of the topics studied in the course; he/she expresses using unsatisfactory language properties.

REVERSE LOGISTICS AND SMART WASTE MANAGEMENT MODULE ASSESSMENT METHODS
Evaluation of student performance in this course will be based on group project, case study discussion, active learning activity and oral exam. Distribution of grades is based on the following percentages:
30%: Project work (teamwork)
20%: Case study discussions (teamwork)
20%: Active learning activity
30%: Oral exam
The assessment of knowledge, competences, and applicative capabilities consists of a project group related on a real business challenge in the field of the circular economy and will count for 30% of the total grade; discussions in class of case studies on the main circular economy models will count for the 20%; the oral exam will count for 30% of the total grade.
The best way to learn is by teaching so the active learning activity is designed to do that. Briefly, the student will pick a topic that applies the circular economy paradigm, and it is of her/his special interest. She/he will then conduct some background research on it, and share her/his findings with the class conducting a real lecture of 15-20 min.
The student assessment is evaluated using the following grades:
Excellent 30-30 cum laude. The student shows excellent knowledge of the topics of the course, excellent language and communication skills, excellent ability to analyze the issues related to the core topics of circular economy, excellent ability to understand real arguments in the settings of the course, excellent ability to connect the topics among them and to develop critical analysis in the field of circular economy. Cum Laude grade is assigned to those students who show a brilliant and well above average ability to sustain a discussion on the core topics of circular economy.
Very good 26-29. The student shows very good knowledge of the topics of the course, very good language and communication skills, very good ability to analyze the issues related to the core topics of circular economy, very good ability to understand real arguments in the settings of the course, very good ability to connect the topics among them and to develop critical analysis in the field of circular economy.
Good 24-25. The student shows good knowledge of the topics of the course, good language and communication skills, good ability to analyze the issues related to the core topics of circular economy, good ability to understand real arguments in the settings of the course, good ability to connect the topics among them and to develop critical analysis in the field of circular economy.
Satisfactory 21-23. The student shows satisfactory knowledge of the topics of the course, satisfactory language and communication skills, satisfactory ability to analyze the issues related to the core topics of circular economy, satisfactory ability to understand real arguments in the settings of the course, satisfactory ability to connect the topics among them and to develop critical analysis in the field of circular economy.
Sufficient18-20. The student shows sufficient knowledge of the topics of the course, sufficient language and communication skills, sufficient ability to analyze the issues related to the core topics of circular economy. The student does not show the ability to understand real arguments in the settings of the course, the ability to connect the topics among them and to develop critical analysis in the field of circular economy.

	Insufficient. The student show he/she has not reached the minimum knowledge of the topics of the course and shows not satisfactory language and communication skills. The student also shows he/she has not reached a sufficient ability to analyze the issues related to the core topics of circular economy. The final grade is the weighted average of the assessments obtained in the three modules. The final grade is given by the arithmetic mean of the scores obtained in the three modules.
TEACHING METHODS	TEACHING METHODS (Circular Economy Business Models Module) Slides will be available before each lesson covering each of the specific topics addressed in the course. Additionally, several case studies will be discussed and presented to favor a continuous and engaging learning path. The cases will describe real experiences implementing a sustainability approach. When applicable, the use of digital technologies will support the learning path, for example, doing online simulations, connecting with practitioners, engaging students through interactive tools. Moreover, students organized in team will be involved in some active learning activities such as for example creating a short video to present a topic related to sustainability management. TEACHING METHODS (Sustainable Manufacturing Module) Frontal as well as practical classes and Group project REVERSE LOGISTICS AND SMART WASTE MANAGEMENT MODULE Slides will be available before each lesson covering each of the specific topics addressed in the course. Additionally, case studies will be discussed and presented to favor a continuous and engaging learning path. The cases will describe real experiences implementing circular economy paradigm. When applicable, the use of digital technologies will support the learning path, for example, doing online simulations, connecting with practitioners, engaging students through interactive tools. Moreover, the students will solve some business challenges that will be announced during the course by working in groups. Each group will solve these challenges and present the outcomes in front of the class by the end of the course.

MODULE
REVERSE LOGISTICS AND SMART WASTE MANAGEMENT

Prof. GIUSEPPE AIELLO

SUGGESTED BIBLIOGRAPHY

Sustainable Supply Chains: A Research-Based Textbook on Operations and Strategy (Springer Series in Supply Chain Management)

AMBIT	50368-Ingegneria gestionale
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54

EDUCATIONAL OBJECTIVES OF THE MODULE

The course aims at providing managerial insights on the design and management of sustainable supply chains and distribution systems, coherently with the modern paradigms of the circular economy and ecological transition. The course will focus in particular on modern optimized approaches to managing the flows of goods within the supply chain and in the final last mile delivery operations, which constitute the most critical element of the entire distribution chain. The course will provide the managers of the futures with adequate skills to face the new challenges of supply chain management in a dynamic technological landscape where new electric and hydrogen propulsion systems call for a renewed approach to the design and management of the supply chains.

SYLLABUS

Hrs	Frontal teaching
2	course introduction
4	Fundamentals of supply chain management and performance evaluation
4	Key performance indicators (KPI) for sustainable supply chain management
5	Models for the evaluation of economic environmental and social impact
4	Multi criteria performance evaluation for of supply chain sustainability
5	optimization of the material flows in the supply chain (raw materials, fnished products, waste and losses)
5	distribution: infrastructures and operations management
5	Sustainable delivery methods, models systems and technologies
5	Sharing Economy and sustainable Last mile delivery models: crowdshipping

Hrs	Practice
5	Project Work: Vehicle routing for green supply chains
5	Project Work: Plant Location optimization models for the supply chain

Hrs	Workshops
5	Case study – Analysis and discussion

MODULE
SUSTAINABLE MANUFACTURING

Prof. GIUSEPPE INGARAO

SUGGESTED BIBLIOGRAPHY	
Notes provided by the teacher. Scientific papers provided by the teacher Material and the Environment (Ecoinformed Material Choice), Micheal F. Ashby, Elsevier, third edition, 2021. ISBN:978-8838667596	
AMBIT	50368-Ingegneria gestionale
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54
EDUCATIONAL OBJECTIVES OF THE MODULE	
The course aims at providing the students with design tools to minimize the environmental impact of products/processes. Overall, the course aims to increase the awareness of young engineers concerning the main factors of influence concerning the environmental impact analysis of product/processes. In other words, the course fosters the life cycle thinking and ecodesign approaches. The course provides skills allowing the students to apply LCE techniques to develop economic and ecological analysis of products and processes.	

SYLLABUS

Hrs	Frontal teaching
2	Introduction to sustainable manufacturing, sustainable development definition, dependence on non-renewable materials
2	The role of material production within the global environmental impact
4	Embodied energy concept, the material life cycle and life cycle based analyses techniques
2	Life cycle assessment based on ISO 14040 procedure
3	Streamlined LCA methods
3	Eco-auditing and methods for accounting for recycling credits
2	End-of-life strategies
5	The Circular Economy Paradigm
3	Additive Manufacturing processes
7	Environmental impact and cost models for manufacturing approaches comparison

Hrs	Practice
9	Apptication of eco-audit tools to different case studies
12	Practical classes aimed at the project work development

MODULE
CIRCULAR ECONOMY BUSINESS MODELS

Prof.ssa ERICA MAZZOLA

SUGGESTED BIBLIOGRAPHY

The course is based on a blend of materials, ranging from book chapters, case histories, articles, teaching notes, and presentations. Teaching notes, case studies and further references to complementary material will be provided by the teacher during the classes.
Suggested Books and useful links:
- HAHN, Rüdiger. Sustainability management: Global perspectives on concepts, instruments, and stakeholders. Rüdiger Hahn c/o Block Services, 2022.
- Ditlev-Simonsen, C. D. (2022). A Guide to Sustainable Corporate Responsibility: From Theory to Action (p. 274). Springer Nature.
- GRI Standard Ed. 2021 (https://www.globalreporting.org/)
- https://ellenmacarthurfoundation.org/

AMBIT	50368-Ingegneria gestionale
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54

EDUCATIONAL OBJECTIVES OF THE MODULE

Inevitably, current and future businesses will need to prioritize sustainability. As a result, sustainability is capturing the interest of organizations, consumers, policy-makers, stakeholders, and business entities globally. Consequently, there is a growing number of organizations that are adopting and executing sustainable business strategies. To effectively tackle this challenge, organizations are actively seeking managers who possess the necessary expertise in this interdisciplinary field. The course is designed to introduce students to the field of sustainability management. It is a conceptual and practical course organized around the core concepts of sustainability. Students will first address the complexity of sustainability, its history, its main components as well as the policies that regulate it. After the introduction of the concepts and history of sustainability, the more theoretical part of the course will present the main theories linking sustainability to business strategies and decisions of firms, such as stakeholder theory, institutional theory and legitimacy theory. The focus will then move on how organizations should plan its sustainability goals, its strategies and operations through the sustainability report instrument. Different models of sustainability reporting will be reviewed (e.g. triple bottom line reporting, environmental, social and governance (ESG) reporting) with a focus on sustainability report and the Global Reporting Initiative (GRI) standard. Finally, will be introduced the concept of sustainable business model focusing on the Circular Economy business model.

SYLLABUS

Hrs	Frontal teaching
3	Introduction to sustainability management: meaning, definition, dimensions of sustainability, current sustainability challenges
4	Sustainability regulations and policies :e.g. the Paris Agreement, Green Deal, Agenda 2030, Task Force on Climate-Related Financial Disclosures -TCFD
4	Sustainability-oriented business related theories: Stakeholder theory; Institutional theory; Legitimacy theory; Stewardship theory
2	Introduction to sustainability measurement and reporting
6	Sustainability reporting and Global reporting Initiative (GRI) standard
5	Sustainable business model: Circular economy business model
8	Active learning activity

Hrs	Practice
8	In class case studies discussions of sustainability examples addressing important or topical issues (individual and teamwork)

Hrs	Workshops
12	Coaching and in class project group presentations (teamwork)