COURSE OUTLINE

(1) GENERAL

SCHOOL	Social Sciences		
ACADEMIC UNIT	Department of Cultural Technology and Communication		
LEVEL OF STUDIES	Postgraduate Studies		
COURSE CODE	UA-TC3	**SEMESTER**	2
COURSE TITLE	Data Analytics and Lifecycle Assessment in Circular Economy		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, state the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail in section (4).	3	6

COURSE TYPE *general background, special background, specialization, general education, skills development*	specialised general knowledge, skills development (technical)
PREREQUISITE COURSES	No
LANGUAGE OF INSTRUCTION AND OF ASSESSMENT	English
MODE OF TEACHING *in-person (%)* *synchronous distance learning (%)* *asynchronous distance learning (%)* *(In the case of synchronous distance learning, the total weekly duration of teaching is recorded)*	The course is delivered exclusively through synchronous distance learning. Each weekly lecture lasts 180 minutes.
AVAILABILITY TO ERASMUS STUDENTS	No
COURSE WEBSITE (URL)	TBA

(2) LEARNING OUTCOMES

Learning Outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Brief Guide for drafting Learning Outcomes*

After the successful completion of the course, the student will be able to:

In terms of knowledge:

- Critically evaluate key concepts of sustainable development, environmental sustainability, natural capital and anthropogenic impacts, and their relevance to circular economy decision-making.
- Demonstrate advanced understanding of Life Cycle Assessment (ISO 14040), including goal/scope definition, system boundaries, functional units, inventory modelling, impact assessment and interpretation.
- Analyse computational and data-structural foundations of process-based LCAs including unit-process models, primary/secondary datasets, and parametric modelling approaches.

- Synthesise sustainability metrics (e.g., circularity indicators, PEF) with LCA frameworks to interpret environmental performance in circular value chains.
- Explain the ethical, legal, governance and transparency dimensions of lifecycle and environmental data, including FAIR principles, bias, uncertainty, and responsible data stewardship.
- Evaluate predictive data-modelling approaches (e.g., ML regression, clustering) for their suitability to address resource optimisation and circularity challenges.

In terms of skills:

- Apply LCA methodology to model simple product systems, compute basic inventory and impact assessments, and interpret environmental hotspots.
- Employ data-science methods to collect, clean, validate and aggregate environmental datasets using parametric and non-parametric approaches.
- Conduct exploratory data analysis using statistical and visual analytics to detect patterns, inconsistencies, and trends in sustainability datasets.
- Design integrated workflows that combine LCA models, circular metrics, and data-analytics pipelines using cloud-based environments and data-management platforms.
- Implement lifecycle analytics for real industrial case studies, translating data insights into sustainable product and process innovation strategies.

In terms of responsibility and autonomy:

- Guide evidence-based sustainability decisions by integrating LCA results, data analytics outputs, and circular economy metrics while accounting for uncertainty and data quality constraints.
- Take responsibility for ethical, transparent and data-secure handling of environmental and lifecycle data, ensuring compliance with FAIR principles and responsible-AI/data governance.
- Manage interdisciplinary LCA and data-analytics projects, coordinating lifecycle modelling, data acquisition, cloud deployment, and stakeholder communication.
- Exercise critical judgement in interpreting analytical outputs, identifying methodological limitations, uncertainty drivers, and required refinements for improved decision-support modelling.
- Coordinate the design, testing and validation of a comprehensive data-driven LCA project, incorporating sustainability science, analytics, modelling, cloud workflows and organisational relevance.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and are stated below), at which of the following does the course aim?

Search, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adaptability to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Production of new research ideas	*Other…*
	…….

Upon successful completion of the course, students will be able to:

- Locate, collect, and critically evaluate environmental and technical data using digital tools, databases, and computational frameworks.
- Integrate knowledge from sustainability science, engineering, and data analytics to address complex environmental challenges.
- Understand and implement data ethics, governance, and compliance in environmental decision-making
- Collaborate effectively within diverse teams and communicate clearly analytical results and sustainability insights.
- Critically analyse data and LCA outcomes to identify key environmental issues and propose evidence-based, innovative solutions.

- Critically evaluate digital product transparency and traceability tools.
- Adapt to new technologies, data analysis methods, and sustainability frameworks in a rapidly evolving interdisciplinary field.
- Design, organise, and execute analytical projects that combine data science and life cycle thinking to support sustainable innovation.
- Apply industry-based lifecycle practices and sustainability analytics in real-world contexts.

(3) COURSE SYLLABUS

UA-TC3: Data Analytics and Lifecycle Assessment in Circular Economy introduces data analysis and analytics techniques, and relevant tools used to perform lifecycle assessments (LCA) of sustainable products. Students will learn how to use data-driven insights to measure and optimise the environmental impact of products, services. The course emphasises the importance of data analytics in decision-making for sustainable circular business practices.

The course consists of 13 lectures, as presented below:

1. **Introduction to sustainable development and environmental sustainability (Instructor: UNL).** This lecture introduces the concepts of sustainable development, environmental sustainability, natural capital, and anthropogenic impacts. Students learn how these concepts are quantified and used to guide circular and environmental decision-making.
2. **Introduction to Life Cycle Assessment: Part 1 (Instructor: POLIMI).** This lecture introduces the principles and methodology of Life Cycle Assessment (LCA) following ISO 14040. Students learn goal and scope definition, system boundaries, and functional units as foundations for conducting LCAs.
3. **Introduction to Life Cycle Assessment: Part 2 (Instructor: UM).** This lecture continues the ISO 14040 methodology by introducing life cycle inventory modelling, impact assessment, and interpretation. Students learn how these stages support environmental performance evaluation.
4. **Data foundations for process-based Life Cycle Assessments (Instructor: DTU).** This lecture explains the mathematical and computational structure of LCAs, focusing on unit-process modelling. It introduces data requirements, primary and secondary datasets, and parametric process models.
5. **Data governance and ethics in environmental and lifecycle data (Instructor: CEF).** This lecture covers ethical and responsible data practices, including privacy, security, FAIR principles, data quality, bias, and transparency. Case examples illustrate dilemmas in environmental modelling and sustainability analytics.
6. **Circular metrics and integration with LCA (Instructor: IETU).** This lecture introduces circularity indicators and explains how circular metrics integrate with LCA and PEF within EU policy frameworks. A workshop provides hands-on experience applying these metrics in practice.
7. **Industry use-cases of lifecycle analytics in sustainable product development (Instructor: CEF).** This lecture presents real-world applications of LCA and analytics in consumer goods, electronics, and automotive industries. Students learn how LCA supports eco-design, reporting and product-lifecycle management.
8. **Introduction to data science and data collection (Instructor: UAEGEAN).** This lecture introduces data-science principles and their relevance to sustainability analytics. It covers sampling, data collection, filtering, cleaning, and modelling of stochastic environmental data.
9. **Fundamentals of data analysis and exploratory data analysis (Instructor: IETU).** This lecture introduces fundamental concepts of exploratory data analysis (EDA), including data charting, statistical summaries, and visual analytics. Students learn to assess data quality, identify trends, and generate analytical insights for later LCA and circularity work.
10. **Interpreting analytical outcomes for circular value chain improvement (Instructor: IETU).** This lecture teaches students to present and interpret analytical results to diagnose inefficiencies, hotspots, and leakages in circular value chains. They reflect methodological limitations and propose improvements for closed-loop optimisation.

11. **Fundamentals of predictive data modelling and applications to marine circular economy (Instructor: UMA).** This lecture introduces regression and machine-learning models for predictive data analysis. Case studies from marine applications illustrate how predictive modelling supports spatial planning and resource optimisation. 12. **Fundamentals of data archival and cloud computing (Instructor: IETU).** This lecture covers best practices for data storage, archival, databases, and data lakes. Students are introduced to cloud platforms (AWS, Google Cloud) for deploying scalable lifecycle-analytics solutions. 13. **Life Cycle Assessment in Practice: Results Interpretation, Limitations and Emerging Possibilities (Instructor: IETU).** This lecture guides students in interpreting LCA results for environmental decision-making and identifying where LCA provides strategic insights. Students evaluate limitations, uncertainties, and emerging analytical opportunities to strengthen future assessments.

(4) TEACHING AND LEARNING METHODS - ASSESSMENT

MODE OF TEACHING *Face-to-face, distance learning, etc.*	Distance Learning
MODE AND FREQUENCY OF COMMUNICATION WITH THE STUDENTS	Synchronous distance communication on a weekly basis, asynchronous on a daily basis through LMS platform
ENSURING THE MODE OF COMMUNICATION AMONG STUDENTS *Team assignments and discussions, collaborative learning platforms with the use of AI, video conference, QA sessions, κ.α.*	Weekly assignments, discussions through dedicated discussion forum, dedicated space per module on the learning platform, schedule video conference meetings through MS Teams, dedicated QA sessions per module
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, in laboratory training, in the communication with students*	Use of ICT in Teaching, Communication with students Online Platforms will be used for teaching, tutorials, students' guidance, students' self-assessment and support on group projects
TECHNOLOGICAL EQUIPMENT REQUIREMENTS	PC /laptop for video conference meeting
PLAGIARISM POLICY/ PLAGIARISM DETECTION TOOLS	Gradescope, Turnitin
ARTIFICIAL INTELLIGENCE POLICY *(1) The use of Artificial Intelligence is prohibited in all circumstances* *(2) The use of Artificial Intelligence is allowed only with the permission of the instructor* *(3) The use of Artificial Intelligence is allowed only with an explicit reference to the literature* *(4) Students are free to use Artificial Intelligence*	The use of Artificial Intelligence is allowed only with an explicit reference to the literature. Additionally, students are free to use AI provided by the master programmes for contacting stimulations, practicing purposes, etc.
ORGANISATION OF TEACHING *The mode and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, work placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artworks, etc.* *The student's study hours for each learning activity are stated, as well as the hours of independent study, according to the principles of the ECTS.*	***Activity*** / ***Semester workload*** Lectures: 39 Participation in forum discussions: 16,5 Study, analysis of bibliography and supplementary consolidation activities: 73,5 Self-Assessment Evaluations: 21 **Course total**: **150**
STUDENT ASSESSMENT *Description of the assessment method*	Students will be evaluated following: Course Project: 50%, distributed:

Language of assessment, methods of assessment, formative or summative assessment, multiple choice questions test, short answer questions, essay questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory assignment, clinical examination of patient, art interpretation, other *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Deliverable 1: 10% Format: public presentation Deliverable 2: 10% Format: public presentation Deliverable 3: 30% Format: public presentation and report Individual Assessment: 50% Format: multiple-choice, short-answer, and open-ended questions.

(5) RECOMMENDED BIBLIOGRAPHY

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