COURSE OUTLINE

(1) GENERAL

SCHOOL	Social Sciences		
ACADEMIC UNIT	Department of Cultural Technology and Communication		
LEVEL OF STUDIES	Postgraduate Studies		
COURSE CODE	UA-EC4	**SEMESTER**	2
COURSE TITLE	AI and Blockchain for Circular Supply Chain Management		
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)*	Synchronous distance learning 100%		
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 the principles of circular supply chain management and explain how digital technologies enable circularity, traceability, and resource efficiency.
- Analyse the technological foundations of AI, predictive analytics, digital twins, and blockchain relevant to sustainable and circular supply networks.
- Demonstrate advanced understanding of data governance, ethical AI, privacy, and responsible blockchain use within circular production ecosystems.
- Explain the role of international standards (e.g., ISO 22739, ISO/TR 23455, ISO/TR 3242) in supporting interoperability, trust, and sustainability in AI/blockchain-enabled supply chains.

In terms of skills:

- Design AI-enabled forecasting, optimisation, and predictive-waste-reduction workflows for circular supply chains.
- Integrate blockchain, smart contracts, and distributed ledgers into circular supply-chain architectures to enhance traceability, compliance, and sustainable transactions.
- Apply digital-twin modelling and IoT-based lifecycle visibility tools to optimise material flows, product lifespan, and reverse-logistics operations.
- Assess the performance of circular supply chains using digital circularity indicators (e.g., material circularity, lifecycle efficiency, carbon metrics) validated by blockchain data.
- Analyse real-world cases to identify how AI and blockchain jointly enable closed-loop logistics, remanufacturing, recycling, and ethical sourcing.

In terms of responsibility and autonomy:

- Drive strategic transformation initiatives that deploy AI and blockchain for sustainable supply-chain redesign within uncertain and complex environments.
- Take responsibility for ensuring ethical, transparent, and socially responsible AI and blockchain deployment in circular supply-chain operations.
- Manage multi-stakeholder implementation projects involving digital platforms, distributed ledgers, and advanced analytics across supply-chain partners.
- Exercise critical judgement in addressing technological barriers—interoperability, scalability, data quality, cybersecurity—when integrating AI and blockchain in circular systems.
- Synthesise course concepts to propose innovative AI- and blockchain-enabled circular supply-chain solutions that address real-world sustainability challenges.

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…*
	…….

The current module will enable students to acquire the following competencies:

- Ethical, responsible, and sustainable decision-making in the design and management of digital supply chains
- Understanding and valuing the role of emerging technologies (AI and blockchain) in promoting transparency, traceability, and environmental stewardship
- Ability to collaborate in multidisciplinary and team-based environments to solve circular supply chain challenges

These competences will be acquired thanks to the topics explored throughout the module and the collaborative activities carried out in groups.

(3) COURSE SYLLABUS

UA-EC4: AI and Blockchain for Circular Supply Chain Management covers how AI and blockchain technologies can improve the efficiency, traceability, and transparency of circular supply chains. Students will learn how these technologies can be applied to optimize material flows, monitor resource use, and reduce waste while ensuring compliance with circular economy principles.

The course consists of 13 lectures, as presented below:

1. **Introduction to circular supply chain management (Instructor: e-Circular).** This lecture introduces the foundations and historical evolution of circular supply chains and their link to the circular economy. Students examine enablers, barriers, managerial implications, and the role of AI, blockchain, and digital platforms in enabling circularity.
2. **Foundations of Artificial Intelligence in Supply Chains (Instructor: ZELUS).** This lecture explores how AI, such as machine learning, predictive analytics, and intelligent automation, transforms supply chain operations. Students analyse applications in forecasting, inventory optimisation, and decision-making that support circular-economy objectives.
3. **Fundamentals of Blockchain Technology (Instructor: WU).** This lecture presents blockchain fundamentals and their use in secure, transparent supply-chain data management. Students learn how distributed ledgers enhance traceability, data integrity, and sustainability reporting.
4. **Integrating AI and Blockchain in circular systems (Instructor: WU).** This lecture examines the convergence of AI and blockchain to support circular and sustainable supply chains. Students evaluate how combining predictive intelligence with decentralised data enables real-time tracking, automation, and reliable sustainability insights.
5. **Traceability and transparency in product lifecycles (Instructor: UNL).** This lecture explores how blockchain ensures product provenance and authenticity across the entire lifecycle. Students examine how IoT sensors and digital twins enhance visibility from raw material sourcing to recycling and ethical circularity metrics.
6. **Predictive analytics for waste reduction (Instructor: UMA).** This lecture introduces AI-driven predictive tools that minimise waste and operational inefficiencies. Students learn how demand forecasting, process optimisation, and lifespan prediction reduce environmental impacts and improve circular resource flows.
7. **Smart contracts for sustainable transactions (Instructor: UMA).** This lecture examines how blockchain-based smart contracts automate and verify sustainable business practices. Students explore applications such as carbon-credit trading, recycling incentives, and supplier-compliance assurance in circular supply chains.
8. **Digital Twins and Resource Optimization (Instructor: WU).** This lecture introduces digital twins for modelling circular supply networks. Students learn how AI simulations and blockchain-based data streams support predictive maintenance, improved resource efficiency, and continuous sustainability optimisation.
9. **Data Governance and Ethical AI (Instructor: UAEGEAN).** This lecture addresses data ownership, privacy, and ethical challenges in AI-driven supply chains. Students evaluate frameworks for responsible AI deployment and secure blockchain data sharing aligned with social responsibility and sustainability requirements.
10. **Case Studies: AI and Blockchain in Circular Logistics (Circularise).** This lecture uses real-world cases to demonstrate AI and blockchain applications in logistics and reverse supply chains. Students analyse systems for material recovery, recycling flows, and closed-loop distribution networks.
11. **Measuring circularity with digital metrics (Instructor: UM).** This lecture introduces digital indicators used to quantify circularity, such as material circularity, carbon footprint, and lifecycle efficiency. Students learn how blockchain-validated data and AI analytics strengthen sustainability measurement.
12. **Challenges and future trends (Instructor: UNL).** This lecture reviews key barriers to adopting AI and blockchain in circular supply chains, including technical, organisational, and regulatory challenges. Students explore scalability concerns, interoperability issues, and emerging innovations shaping future supply-chain sustainability.

Standards for AI and Blockchain in Circular Supply Chains (Instructor: CYS). This lecture presents international standards that underpin trust and interoperability in AI and blockchain for circular supply chains. Students explore ISO/TR 3242, ISO/TR 23455, ISO 22739 and related standards that support tracking, smart contracts, and consistent terminology.

(4) TEACHING AND LEARNING METHODS - ASSESSMENT

<table>
<tr><td>MODE OF TEACHING
Face-to-face, distance learning, etc.</td><td>Distance Learning</td></tr>
<tr><td>MODE AND FREQUENCY OF COMMUNICATION WITH THE STUDENTS</td><td>Synchronous distance communication on a weekly basis, asynchronous on a daily basis through LMS platform</td></tr>
<tr><td>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.</td><td>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</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, in laboratory training, in the communication with students</td><td>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</td></tr>
<tr><td>TECHNOLOGICAL EQUIPMENT REQUIREMENTS</td><td>PC /laptop for video conference meeting</td></tr>
<tr><td>PLAGIARISM POLICY/ PLAGIARISM DETECTION TOOLS</td><td>Gradescope, Turnitin</td></tr>
<tr><td>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</td><td>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.</td></tr>
<tr><td>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.</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>39</td></tr>
<tr><td>Participation in forum discussions</td><td>16,5</td></tr>
<tr><td>Study, analysis of bibliography and supplementary consolidation activities</td><td>73,5</td></tr>
<tr><td>Self-Assessment Evaluations</td><td>21</td></tr>
<tr><td>Course total</td><td>150</td></tr>
</table>
</td></tr>
<tr><td>STUDENT ASSESSMENT
Description of the assessment method

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.</td><td>Students will be evaluated following multiple-choice, short-answer, and open-ended questions.

The assessment formula is the following:

Self-Assessment Evaluations: 50%
Final Assessment: 50%</td></tr>
</table>

(5) RECOMMENDED BIBLIOGRAPHY

[1] G. Singh and M. Rizwanullah, “Combinatorial optimization of supply chain networks: A retrospective and literature review,” Materials Today: Proceedings, vol. 62, no. 3, pp. 1636–1642, 2022, doi: 10.1016/j.matpr.2022.04.366.
[2] H. Stadtler, C. Kilger, and H. Meyr, Eds., Supply Chain Management and Advanced Planning: Concepts, Models, Software and Case Studies, 5th ed. Berlin, Germany: Springer, 2015, doi: 10.1007/978-3-642-55309-7.
[3] G. Culot et al., “Artificial intelligence in supply chain management: A systematic literature review,” Journal of Purchasing & Supply Management, 2024, doi: 10.1016/j.pursup.2024.101045.
[4] A. Daios, N. Kladovasilakis, A. Kelemis, and I. Kostavelis, “AI applications in supply chain management: A survey,” Applied Sciences, vol. 15, no. 5, p. 2775, 2025, doi: 10.3390/app15052775.
[5] M. A. Mediavilla et al., “Review and analysis of artificial intelligence methods for supply chain planning and optimization,” Computers & Industrial Engineering, vol. 162, Art. 107691, 2022, doi: 10.1016/j.cie.2021.107691.
[6] H. Kagalwala, “The role of AI and machine learning in demand forecasting,” Accounting & Corporate Reporting Journal, 2025, doi: 10.1234/acrj.2025.036.
[7] J. Jones, “Exploring the role of artificial intelligence in optimizing supply chain operations,” SSRN, 2025, doi: 10.2139/ssrn.5207793.
[8] S. Assemlali and M. Sabar, “Circular supply chain: A systematic review,” Advances in Manufacturing Technology, vol. 25, pp. 379–384, 2022, doi: 10.3233/ATDE220620.
[9] P. C. Sosnowski, “The role of circular supply chains in sharing economy: Literature review and conceptual framework,” International Journal of Innovation and Sustainable Development, vol. 18, no. 3, pp. 350–379, 2024, doi: 10.1504/IJISD.2023.10056912.
(Corrected page range: original text “350–279” inverted; IEEE assumes correct ascending pagination: “350–379”)
[10] E. Taddei, C. Sassanelli, P. Rosa, and S. Terzi, “Circular supply chains in the era of Industry 4.0: A systematic literature review,” Computers & Industrial Engineering, vol. 170, Art. 108268, 2022, doi: 10.1016/j.cie.2022.108268.
[11] B. Wu, H. Chen, and Y. Shi, “Influence of artificial intelligence development on supply chain diversification,” Finance Research Letters, vol. 78, Art. 107210, 2025, doi: 10.1016/j.frl.2025.107210.
[12] G. Culot, M. Podrecca, and G. Nassimbeni, “Artificial intelligence in supply chain management: A systematic literature review of empirical studies and research directions,” Computers in Industry, vol. 162, Art. 104132, 2024, doi: 10.1016/j.compind.2024.104132.
[13] A. de Vries-Gao, “Artificial intelligence: Supply chain constraints and energy implications,” Joule, vol. 9, no. 6, pp. 1–5, 2025, Art. 101961, doi: 10.1016/j.joule.2025.101961.