

COURSE OUTLINE

(1) GENERAL

SCHOOL	Social Sciences		
ACADEMIC UNIT	Department of Cultural Technology and Communication		
LEVEL OF STUDIES	Postgraduate Studies		
COURSE CODE	UA-EC1	SEMESTER	2
COURSE TITLE	Deep-Tech Driven Energy Transformation		
INDEPENDENT TEACHING ACTIVITIES <i>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</i>	WEEKLY TEACHING HOURS	CREDITS	
<i>Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail in section (4).</i>	3	6	
COURSE TYPE <i>general background, special background, specialization, general education, skills development</i>	specialised (technical)	general	knowledge, skills development
PREREQUISITE COURSES	No		
LANGUAGE OF INSTRUCTION AND OF ASSESSMENT	English		
MODE OF TEACHING <i>in-person (%) synchronous distance learning (%) asynchronous distance learning (%) (In the case of synchronous distance learning, the total weekly duration of teaching is recorded)</i>	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

<p>Learning Outcomes</p> <p><i>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.</i></p> <p><i>Consult Appendix A</i></p> <ul style="list-style-type: none"> • <i>Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area</i> • <i>Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B</i> • <i>Brief Guide for drafting Learning Outcomes</i> <p>After the successful completion of the course, the student will be able to:</p> <p>In terms of knowledge:</p> <ul style="list-style-type: none"> • Critically evaluate the principles, architectures, and operational dynamics of smart grids, renewable energy systems, energy-flexibility mechanisms, and digital-twin-driven energy infrastructures. • Demonstrate advanced understanding of AI, IoT, embedded sensing, edge computing, and blockchain as enablers of resilient, low-carbon, and circular energy ecosystems. • Analyse human-centred and socio-technical dimensions of deep-tech adoption, including ergonomics, safety, human-machine interaction, and the social impacts of digitalisation.
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- Synthesise knowledge on energy justice, inclusive access, and sustainability ethics to assess deep-tech impacts on vulnerable/underserved communities.
- Explain the environmental, operational, and governance implications of AI-powered digital twins and CPS modelling for distributed and renewable energy systems.
- Evaluate digital-twin architectures and distributed simulation models to support decision-making in energy sharing, sector coupling, and CPS optimisation.

In terms of skills:

- Design AI-enabled forecasting, optimisation, and predictive-maintenance solutions that improve grid efficiency, renewable integration, and resource circularity.
- Apply IoT, embedded sensing, and smart-material technologies to monitor lifecycle performance, enhance maintenance strategies, and support closed-loop energy systems.
- Integrate edge–cloud data pipelines, real-time analytics, and interoperability standards to create data-driven solutions for energy optimisation and circularity.
- Assess deep-tech strategies for regenerative urban infrastructure, identifying opportunities to enhance circularity, resilience, and long-term value.

In terms of responsibility and autonomy:

- Lead strategic decision-making on deep-tech adoption in energy systems, balancing innovation, ethics, environmental impact, regulatory demands, and social equity.
- Manage complex, cross-disciplinary energy-transformation projects involving AI, IoT, digital twins, CPS, robotics, and human-factor considerations.
- Take responsibility for ethical, inclusive, and sustainable deployment of digital energy technologies, ensuring energy justice and fair digitalisation across communities.
- Apply advanced judgement in selecting, configuring, and governing deep-tech systems under uncertainty, cybersecurity constraints, and operational risk.
- Coordinate the integration of AI, IoT, digital twins, CPS modelling, and renewable-energy architectures to create circular, low-carbon, resilient energy ecosystems.

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?

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

The current course will enable students to acquire the following competences:

- Search for, analysis and synthesis of data and information, with the use of the necessary technology, as UA-EC1 requires students to work with AI-driven forecasting, IoT sensor data, digital twins, CPS modelling, predictive maintenance, and blockchain-enabled traceability.
- Strategic and innovative thinking for managerial problem-solving, as students must design and evaluate deep-tech strategies for smart grids, renewable integration, energy flexibility, and urban infrastructure.
- Working in an interdisciplinary environment, as the course merges energy engineering, AI/ML, IoT/edge computing, blockchain, human factors, ethics, and social sciences (e.g., energy justice).
- Ethical, responsible, and sustainable decision-making in business contexts, as lectures on energy justice, human-centred automation, sustainability, and equitable digitalisation (6 and 9) build competence in ethical judgement. UA-EC1 explicitly addresses fairness, social inclusion, safety, environmental preservation, and responsible deployment of AI and deep-tech.

- Leadership and team coordination in complex or multicultural environments, as the course trains students to lead energy-system transformation projects involving engineers, policymakers, communities, ICT specialists, and industry stakeholders.

(3) COURSE SYLLABUS

UA-EC1: Deep-Tech Driven Energy Transformation explores how deep-tech innovations such as AI, IoT, and blockchain can be applied to transform the energy sector towards being green and sustainable. Students will learn how to optimise energy systems, integrate renewable energy solutions, and manage energy resources more efficiently in line with circular economy principles.

The course consists of 13 lectures, as presented below:

1. **AI in Energy Systems: forecasting, optimisation, and predictive maintenance (Instructor: UAEGEAN).** This lecture explores how AI improves energy efficiency through demand forecasting, grid optimisation, and predictive maintenance. Students examine ML models that enhance renewable-energy integration, smart-grid reliability, and cost-effective operation.
2. **Smart grids for low carbon emissions (Instructor: UNL).** This lecture introduces the architecture and operation of smart grids designed to support low-carbon energy systems. Students explore how digitalisation, automation, and distributed energy resources contribute to emission reduction.
3. **Net Zero Energy Buildings (Instructor: UNL).** This lecture examines the principles and technologies enabling buildings to achieve net-zero energy performance. Students analyse smart building systems, renewable integration, and digital tools that optimise consumption and lifecycle performance.
4. **Renewable Energy Communities (Instructor: UNL).** This lecture introduces decentralised energy communities as models for shared, circular, and renewable energy production. Students explore governance structures, digital technologies, and business models enabling local energy exchange.
5. **Energy Flexibility (Instructor: UNINOVA).** This lecture examines how energy flexibility enables demand–response, peak-load management, and efficient grid operation. Students analyse digital mechanisms and market structures supporting flexible and sustainable energy systems.
6. **Human factors in sustainable industrial ecosystems (Instructor: CEA).** This lecture explores human–AI–robot collaboration, ergonomics, and safety in data-intensive energy and industrial environments. Students learn human-centred design principles for ethical, resilient, and sustainable automated ecosystems.
7. **Smart materials and embedded sensing for lifecycle management (Instructor: CEA).** This lecture examines how smart materials and embedded sensors enable lifecycle monitoring, predictive maintenance, and circular design. Students study sensor data interpretation and integration within sustainable manufacturing systems.
8. **IoT and edge computing for sustainable industrial ecosystems (Instructor: CEA).** This lecture introduces IoT and edge-computing architectures that support real-time analytics, predictive maintenance, and closed-loop operations. Students learn how distributed sensing and cloud-edge integration increase efficiency and traceability.
9. **Energy justice and the social dimensions of energy transition (Instructor: CEF).** This lecture investigates how benefits and burdens of energy transitions are distributed, focusing on equity, affordability, and inclusivity. Students critically assess how deep-tech tools—AI pricing, smart meters, digital twins—can either reduce or reinforce inequalities.
10. **Technology, circularity and the future of urban infrastructure (Instructor: EGC).** This lecture examines how AI, IoT, and digital twins reshape resource flows, building performance, and infrastructure resilience. Students analyse examples of data-enabled construction, predictive maintenance, and ethical considerations for regenerative urban systems.
11. **Energy grids as networks of interconnected digital twins (Instructor: MAG).** This lecture analyses energy grids as multi-layer networks of digital twins supporting energy sharing,

<p>demand response, and data sovereignty. Students engage in hands-on exercises with the MIRA digital-twin platform.</p> <p>12. Use of digital twins and AI for modelling cyberphysical systems in the energy domain (Instructor: FRAMATOME). This lecture introduces key renewable-energy and storage technologies and their modelling through CPS frameworks. Students explore AI-supported optimisation, IIoT performance analysis, and predictive maintenance for complex energy systems.</p> <p>13. AI-Powered digital twins for sustainable energy systems (Instructor: UBITECH). This lecture explores how AI-driven digital twins enhance monitoring, predictive maintenance, and optimisation of energy assets. Students learn how these technologies support renewable integration, efficiency gains, and emissions reduction.</p>
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(4) TEACHING AND LEARNING METHODS - ASSESSMENT

<p>MODE OF TEACHING <i>Face-to-face, distance learning, etc.</i></p>	Distance Learning	
<p>MODE AND FREQUENCY OF COMMUNICATION WITH THE STUDENTS</p>	Synchronous distance communication on a weekly basis, asynchronous on a daily basis through LMS platform	
<p>ENSURING THE MODE OF COMMUNICATION AMONG STUDENTS <i>Team assignments and discussions, collaborative learning platforms with the use of AI, video conference, QA sessions, κ.α.</i></p>	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	
<p>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY <i>Use of ICT in teaching, in laboratory training, in the communication with students</i></p>	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	
<p>TECHNOLOGICAL EQUIPMENT REQUIREMENTS</p>	PC /laptop for video conference meeting	
<p>PLAGIARISM POLICY/ PLAGIARISM DETECTION TOOLS</p>	Gradescope, Turnitin	
<p>ARTIFICIAL INTELLIGENCE POLICY (1) <i>The use of Artificial Intelligence is prohibited in all circumstances</i> (2) <i>The use of Artificial Intelligence is allowed only with the permission of the instructor</i> (3) <i>The use of Artificial Intelligence is allowed only with an explicit reference to the literature</i> (4) <i>Students are free to use Artificial Intelligence</i></p>	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.	
<p>ORGANISATION OF TEACHING <i>The mode and methods of teaching are described in detail.</i> <i>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.</i></p> <p><i>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.</i></p>	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
<p>STUDENT ASSESSMENT <i>Description of the assessment method</i></p> <p><i>Language of assessment, methods of assessment, formative or summative assessment, multiple choice questions test, short answer questions, essay questions,</i></p>	<p>Students will be evaluated following multiple-choice, short-answer, and open-ended questions.</p> <p>The assessment formula is the following:</p>	

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.

Self-Assessment Evaluations: 50%
Final Assessment: 50%

(5) RECOMMENDED BIBLIOGRAPHY

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