[Digitalization and Sustainable Development: AI-ML Tools for Sustainability]
[Duration: Contact hours/Self-study]
[Class Days/Times/Timezone]
[Location/Online(Synchronous/Asynchronous)]

Course Overview*: Welcome to "*Digitalization and Sustainable Development: AI-ML Tools for Sustainability*" (EQF 7). This advanced course explores how digital transformation—particularly through artificial intelligence (AI) and machine learning (ML)—can accelerate sustainability goals in the built environment. By analyzing real-world cases, focusing on practical AI/ML techniques (supervised vs. unsupervised learning), and introducing basic NLP (Transformers, vector databases), participants will gain the multidisciplinary skill set required to excel in sustainability-focused digital projects.*

Title	Digitalization and Sustainable Development: AI-ML Tools for Sustainability
Code	
EQF Level	7
Conduct mode	Online (Synchronous + Asynchronous)
Aims of the Course	*Short description* • Equip participants with practical AI/ML skills (supervised, unsupervised, basic NLP) tailored to sustainability challenges in the built environment. • Foster data-driven decision-making by guiding learners to design, implement, and communicate digital solutions that address resource efficiency, environmental impact, and policy needs. • Develop ethical and stakeholder awareness, ensuring responsible adoption of digital technologies aligned with SDGs and relevant regulations.
Learning Methods	• **Lectures & Seminars**: Introduce theoretical concepts and frameworks in AI/ML and sustainability. • **Hands-On Workshops**: Practical coding sessions in Python/R for data handling, model building, and NLP tasks.

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	• **Case Studies & Problem-Based Learning**: Real-world sustainability scenarios (energy optimization, policy analysis) to strengthen problem-solving and collaboration. • **Project Work**: Capstone or group projects tackling a specific sustainability challenge, culminating in a presentation or report. • **Discussions & Peer Feedback**: Regular interaction among learners to exchange ideas, refine solutions, and cultivate critical thinking.
Learning Outcomes	By the end of this course, participants will be able to: 1. **Apply** supervised and unsupervised ML algorithms to analyze sustainability data (energy, resources, environment). 2. **Experiment** with basic NLP methods (Transformers, vector databases) to parse policy or sustainability documents. 3. **Evaluate** ethical, social, and regulatory dimensions of digital solutions in sustainability projects. 4. **Formulate** data-driven proposals that address real-world challenges in the built environment, aligning with SDGs. 5. **Communicate** insights effectively to stakeholders, bridging technical details with sustainability objectives.
Prerequisites	• **Bachelor's (EQF Level 6) in a related field** (e.g., environmental science, engineering, computer science, economics, sustainability management, natural sciences), **OR** equivalent professional experience • **Proficiency in English** and **basic computer skills** (spreadsheets, online tools) • **Basic knowledge** of mathematics and data analysis (recommended) • Familiarity with **Python or R** is **highly recommended**

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Course structure: outline of sessions	*e.g. Weekly schedule with titles*
Learning Resources	*e.g. Books, Videos, Online Material (as a reference list)*
Assessment methods	*e.g. Written exam XX%* *Presentation XX%*
Language	

Course Description

This EQF Level 7 course, Digitalization & AI-ML Expert in Sustainability, is designed to equip participants with practical AI-ML skills for tackling environmental and resource-management challenges in the built environment. Delivered online (mix of synchronous sessions and asynchronous tasks), it covers supervised and unsupervised learning, an intro to NLP (Transformers, vector databases), and ethical & policy considerations. Students will engage in project work, analyzing real-world data and proposing solutions aligned with sustainability goals (SDGs). The course suits professionals or advanced learners seeking to integrate digital solutions with sustainable development objectives.

Learning Outcomes & Expectations

- **Apply** ML techniques (supervised, unsupervised) and basic NLP to sustainability data.
- **Design** small-scale AI solutions to address energy/resource efficiency or policy mapping in the built environment.
- **Evaluate** ethical, social, and regulatory aspects of digital transformation, particularly in green contexts.
- **Communicate** findings effectively, bridging technical insights with stakeholder-friendly narratives.

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- **Collaborate** on capstone projects, demonstrating both independent research and teamwork in data-driven sustainability.

Detailed Description of the Course Schedule:

Table 1 Sample Course Schedule

Week & Topic	Description of session	Assignment / Coursework	Assignment Deadline (Date/Time)
Week 1: Intro to Digitalization & Sustainability	Overview of sustainability challenges (SDGs, circular economy) and the role of AI-ML in the built environment	Reflection: short piece describing a local sustainability challenge + potential digital solutions	End of Week 1
Week 2: Supervised Learning Fundamentals	Introduction to classification/regression basics; short coding demos (Python/R)	Online Quiz: core AI-ML concepts (multiple-choice & short-answer)	End of Week 2
Week 3: Unsupervised Learning Basics	Clustering, dimensionality reduction for resource/energy data; ethical considerations (bias/fairness)	Workshop Exercise: analyze a small dataset using clustering	End of Week 3
Week 4: Data Ethics & Regulatory Frameworks	Privacy, bias, fairness; relevant EU directives/regulations for AI in sustainability	Discussion Post: evaluate an ethical scenario case study	Mid-Week 4
Week 5: Tools & Platforms for ML	Hands-on workshops (Python/R) for data handling, simple feature engineering, model evaluation	Practical Task: data wrangling and basic ML model setup	End of Week 5
Week 6: Introduction to NLP: Transformers & Vector DBs	Basic NLP tasks (tokenization, embeddings),	NLP Assignment: experiment with text embedding on a short	End of Week 6

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	fundamentals of Transformer models, storing embeddings in vector databases	policy or sustainability document	
Week 7: Workshop: NLP & Policy Documents	Applying NLP to parse sustainability/policy documents; analyzing textual data for insights	Mini-Project Proposal: outline group/individual ML/NLP project addressing a sustainability problem	End of Week 7
Week 8: AI in Energy & Resource Management	Case studies on resource optimization, data analytics for energy/circular economy	Project Concept Submission: identify data sources, approach, and expected outcomes	End of Week 8
Week 9: Project Development: Mid-Review	Group/individual project proposals; peer feedback + instructor guidance	Mid-Project Slides: partial results + next steps	During Week 9
Week 10: Policy & Stakeholder Engagement	Communication strategies, aligning project results with policy/regulations, stakeholder mapping	Reflection: short memo on stakeholder alignment	End of Week 10
Week 11: Advanced Work on Projects + Ethical Review	Refining solutions, verifying approach meets ethical/regulatory standards	Draft Final Project: incorporate feedback, finalize approach	End of Week 11
Week 12: Final Project Presentations	Formal presentations of solutions, Q&A, group discussion	Final Submission: written report + 15-minute presentation	Presentation Day (Week 12)
Week 13: Wrap-Up & Future Outlook	Course reflection, potential next steps (further education, advanced modules), optional exit survey	Post-Course Reflection: summarize learning outcomes	End of Week 13

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Learning Resources:

Below is a **compiled list of open-access resources** for **R** and **Python**, including books that cover data science fundamentals, machine learning, and natural language processing. All are **free** and can be accessed online.

R for Data Science (2nd Edition)

• **Author(s):** Hadley Wickham, Mine Çetinkaya-Rundel & Garrett Grolemund

• **URL:** https://r4ds.hadley.nz/

• **Overview:**

• Introduces data science workflows in R (data import, tidying, visualization, modeling).

• Ideal for anyone seeking a systematic approach to data analysis in R.

Natural Language Processing with Python (NLTK Book)

• **Authors:** Steven Bird, Ewan Klein, and Edward Loper

• **URL:** https://www.nltk.org/book/

• **Overview:**

• Focuses on text analysis using the Natural Language Toolkit (NLTK) in Python.

• Covers corpora handling, tokenization, tagging, classification, and more.

Python Data Science Handbook

• **Author:** Jake VanderPlas

• **URL:** https://jakevdp.github.io/PythonDataScienceHandbook/

• **Overview:**

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• Explores core Python libraries for data science (NumPy, pandas, matplotlib, scikit-learn).

• Includes practical code examples and in-depth explanations.

Applied Machine Learning in Python: A Hands-on Guide with Code

• **Author:** Michael J. Pyrcz (University of Texas at Austin)

• **URL:** https://geostatsguy.github.io/MachineLearningDemos_Book/intro.html

• **Overview:**

• Offers free, online chapters with workflows and examples in Python.

• Covers probability concepts, data loading, feature transformation, and practical ML.

scikit-learn Documentation (Machine Learning in Python)

• **URL:** https://scikit-learn.org/stable/

• **Overview:**

• Official documentation for scikit-learn, a widely used Python ML library.

• Contains tutorials, examples, and API references for classification, regression, clustering, etc.

Speech and Language Processing (3rd Edition Draft)

• **Authors:** Daniel Jurafsky & James H. Martin

• **URL:** https://web.stanford.edu/~jurafsky/slp3/

• **Overview:**

• A comprehensive NLP text covering text processing, language models, classification, embeddings, and more.

• Regularly updated draft chapters are freely available.

Assessment methods:

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Written Exam (30–40%)

• *Format:* Multiple-choice & short-answer questions

• *Coverage:* ML fundamentals (supervised/unsupervised learning), basic NLP, sustainability frameworks (SDGs, circular economy)

• *Duration:* ~60–90 minutes, passing mark ≥ 60%

• *Rationale:* Ensures a solid theoretical understanding of both AI concepts and sustainability contexts

Project or Practical Assessment (30–40%)

• *Format:* Group or individual project applying AI/ML to a sustainability challenge (e.g., energy optimization, policy text analysis)

Deliverables:

1. **Short written report** outlining objectives, methodology, data sources, results, and conclusions

2. **Presentation** (10–15 minutes) demonstrating solution approach and outcomes

• *Rationale:* Evaluates real-world application, teamwork, and technical proficiency

Participation & Presentations (20–30%)

Components:

• Weekly or milestone-based oral presentations

• Peer feedback sessions and discussions in forums

• *Rationale:* Encourages active engagement, collaboration, and continuous knowledge exchange

Instructors and Office hours:

Primary Instructor: Dr. Georgios Feretzakis
Instructor's name: Dr. Georgios Feretzakis

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Instructor's email: gferetzakis@aueb.gr
Office Hours:

Secondary Instructor: Dr. Dimitrios Karapiperis
Instructor's name: Dr. Dimitrios Karapiperis
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