COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Engineering		
ACADEMIC UNIT	Department of Financial and Management Engineering		
LEVEL OF STUDIES	Postgraduate		
COURSE CODE	I.1	**SEMESTER**	A
COURSE TITLE	AI and Machine Learning		
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**
	Lectures	3	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail in section (4).			
COURSE TYPE *general background, special background, specialization, general education, skills development*	General background		
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)	https://aisbd.aegean.gr/el/c/ai-and-machine-learning		

(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*

Upon successful completion of this module, students will be able to:

1. Understand core AI and ML concepts, including learning paradigms (supervised, unsupervised, reinforcement, and generative learning), types of AI (narrow vs. general; predictive and generative), and key capabilities such as learning, reasoning, and problem-solving.
2. Understand the mathematical and computational foundations underlying major ML model families, from classical algorithms to deep learning and foundation models.
3. Describe the end-to-end machine learning lifecycle, including data collection, reprocessing, feature engineering, training, validation, deployment, and monitoring.

4. Assess the suitability of different AI/ML models for specific business problems, recognizing trade-offs between diverse priorities, e.g., performance, interpretability, scalability, cost, and risk.
5. Identify and diagnose common modeling challenges, such as underfitting/overfitting, data leakage, data quality issues.
6. Interpret and critically evaluate model outputs at both a technical and managerial level, including uncertainty, limitations, and potential biases.
7. Evaluate how different AI-powered technologies can be leveraged to support business strategizing, redesign processes, and improve decision-making across organizational functions.
8. Manage and oversee AI-enabled projects and infrastructures, working effectively with technical teams while aligning AI initiatives with business objectives.
9. Analyze organizational, ethical, and governance considerations related to AI deployment, including data governance, accountability, and socio-technical expectations.
10. Communicate AI-related insights effectively to technical and non-technical stakeholders.
11. Make informed, responsible decisions regarding the adoption, deployment and use of AI systems in complex, real-world business environments.

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

Search, analysis and synthesis of data and information, with the use of the necessary technology
Adaptability to new situations
Decision-making
Working independently and team work
Working in an interdisciplinary environment
Production of new research ideas
Project planning and management
Production of free, creative and inductive thinking

(3) COURSE SYLLABUS

Lecture 1: Fundamentals of Artificial Intelligence and Machine Learning

What is AI, Historical Evolution of the field and State of the Art Models and Business Applications

Lecture 2: Machine Learning Introduction

Forms of Learning, Supervised Learning, Learning Decision Trees. Model Selection and Optimization. The Theory of Learning. Linear Regression and Classification, Nonparametric Models, Ensemble Learning. Developing Machine Learning Systems

Lecture 3: Supevised Learning Theory and Models

Decision trees, linear models, and neural networks (at a conceptual level) in detail- their respective strengths, limitations, and typical business use cases. The bias-variance trade-off as a unifying framework for understanding model complexity, generalization, and robustness in real-world settings. Core learning concepts: loss functions, generalization, and overfitting are explored from both a technical and managerial perspective, enabling students to interpret model behavior and evaluation results beyond the respective model performance metrics.

Lecture 4. Tree-Based Algorithms for Supervised Learning: Foundations and Advanced Models

Fundamental principles of decision trees, including recursive partitioning, impurity measures (e.g. Gini impurity, entropy, variance reduction), and stopping criteria. Advanced tree-based ensemble models, including Random Forests and Gradient Boosting methods (i.e. AdaBoost, Gradient Boosted Trees, XGBoost/LightGBM at a descriptive level). Trade-offs between interpretability, accuracy, and computational cost, as well as practical considerations such as feature importance, handling of missing data, class imbalance, and hyperparameter tuning.

Lecture 5. Unsupervised Learning: Clustering

Classical clustering models (i.e. k-means and hierarchical clustering) as well as state ofthe-art approaches used in modern AI systems, incuding density-based methods.

Lecture 6. Neural Networks

Core characteristics, principles of neural networks, including neurons, layers, activation functions, loss functions, and gradient-based optimization. Examples over popular platforms.

Lecture 7. Deep Learning Architectures

Deep Learning architectures, including feedforward networks, recurrent neural networks (RNNs), Long Short-Term Memory (LSTM) networks, and gated architectures, alongside modern sequence models such as Temporal Convolutional Networks (TCNs) and Transformer-based approaches at a conceptual level.

Lecture 8. Reinforcement Learning

Reinforcement Learning (RL) as a machine learning paradigm for sequential decision-making and control, in which an agent learns optimal behavior through interaction with an environment. Model-free approaches i.e. Q-learning are then discussed. Exploration–exploitation trade-offs, convergence guarantees, and sample efficiency. Deep Reinforcement Learning (DRL), Deep Q-Networks (DQN), policy gradient methods, and actor–critic models. State-of-the-art DRL models, i.e. Proximal Policy Optimization (PPO), Deep Deterministic Policy Gradient (DDPG), and Soft Actor–Critic (SAC)

Lecture 9. Large Language Models

Word Embeddings. Recurrent Neural Networks for Language. Sequence-to-Sequence Models. Transformer Architecture.Pretraining and Transfer Learning, State of the art models.

Lecture 10: Generative AI: Architectures, Capabilities, and Business Impact

Charateristics and comparison with classical predictive models; understanding data distributions and novel output generation. Transformers, diffusion models, and latent-variable approaches (VAEs, GANs). Foundation Models at Scale: emergent behaviour, pretraining, and task adaptation. Business Application. Risks and Governance: hallucination, bias, IP concerns, and regulatory responsibilities.

(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>● Communication mainly via email and the e-class / e-class platform (announcements, materials, instructions).
● Scheduled weekly office hours for questions (in person or online).</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>Team assignments and discussions, collaborative learning platforms</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.
● Use of e-class for communication with students.</td></tr>
<tr><td>TECHNOLOGICAL EQUIPMENT REQUIREMENTS</td><td>-</td></tr>
<tr><td>PLAGIARISM POLICY/ PLAGIARISM DETECTION TOOLS</td><td>Use of Turnitin tool.</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.</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>Attendance and study of lectures</td><td>60</td></tr>
<tr><td>Assignment writing</td><td>40</td></tr>
<tr><td>In-class practical exercises (hands-on)</td><td>20</td></tr>
<tr><td>Assessment questions in each module</td><td>15</td></tr>
<tr><td>Study of additional learning materials (videos, articles, etc.)</td><td>15</td></tr>
<tr><td>Course total</td><td>150</td></tr>
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<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,</td><td>Final Exam: Multiple choice questions test and short answer questions. Written work, essay/report (60%).

Oral examination and public presentation (40%).</td></tr>
</table>

laboratory assignment, clinical examination of patient, art interpretation, other *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	

(5) RECOMMENDED BIBLIOGRAPHY

- Suggested bibliography:

Russell and Norvig (2021). Artificial intelligence: A modern approach (4th ed., 2021)
Reddi (2026) Introduction to Machine Learning Systems
Hastie, Tibshirani, and Friedman. The Elements of Statistical Learning (2nd ed., 2009)
Bishop. Pattern Recognition and Machine Learning (2006).
Shwartz and David. Understanding Machine Learning: From Theory to Algorithms (2014)

- Related academic journals:

Communications of the ACM, IEEE Journals, AIS Journals

- Seminal Papers per Topic and Lecture