COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Department of Digital Industry Technologies		
LEVEL OF STUDIES	Postgraduate (MSc on Robotics and Industrial Control)		
COURSE CODE	**002**	**SEMESTER**	1st
COURSE TITLE	Artificial Intelligence in Industrial Control Systems		
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, give the weekly teaching hours and the total credits	**WEEKLY TEACHING HOURS**		**CREDITS**
Lectures	3		8
Total	3		8
COURSE TYPE *special background, specialised general knowledge, skills development*	Specialization Course		
PREREQUISITE COURSES:	---		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek and/or English		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes, under conditions		
COURSE WEBSITE (URL)	https://ric-en.dind.uoa.gr/el/studies/curriculum/1st_semester/artificial_intelligence_in_industrial_control_systems/		

(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*
- *Guidelines for writing Learning Outcomes*

Aim of the course is to familiarize students with the application of artificial intelligence tools in industrial systems, toward control systems design and performance optimization. Special emphasis is placed on chemical and manufacturing processes. Upon successful completion of the course, students will be able to:

• Understand the function of artificial intelligence tools, tuning performance variables of industrial processes,

• Apply machine learning tools for real-time control in industrial processes,

• Design and implement fuzzy controllers,

• Design and implement safe switching controllers for industrial processes,

• Apply simulating annealing, neural networks, and metaheuristic techniques to optimize the degrees of freedom in control schemes.

• Design and implement expert systems and decision support systems, being based on artificial intelligence tools,

• Apply artificial intelligence tools to develop fault diagnosis and predictive maintenance systems.

General Competences

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

Search for, analysis and synthesis of data and information, Project planning and management Respect for difference and

with the use of the necessary technology *Adapting to new situations Decision-making* *Working independently Team work* *Working in an international environment Working in an interdisciplinary environment Production of new research ideas*	*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* *……* *Others…* *…….*

Search for, analysis and synthesis of data and information, with the use of the necessary technology, Decision-making, Working independently, Team work, Project planning and management , Criticism and self-criticism, Production of free, creative and inductive thinking.

(3) SYLLABUS

Principles of Artificial Intelligence (AI). Aspects of Design and Software for AI systems. Directions in the application of AI to industrial control systems. Machine Learning applications for Real Time Control of industrial processes. Cognitive Approaches for Self-Optimizing Machines. Neural network control software platforms. Fuzzy control software platforms. Stepwise Safe Switching. Simulating annealing and Metaheuristic Optimization Algorithms for controller regulation. Expert industrial control systems. AI based Industrial Decision support systems. Artificial intelligence and predictive maintenance. Fault Detection and Diagnostics. AI approaches for product and process quality control and inspection. Industrial applications in Chemical Processes and Manufacturing. Simulations for AI control systems and Software Platforms.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to face, Synchronous and Asynchronous distance learning
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Supporting the learning process through • use of an electronic platform for interactive two-way communication and participation, • use of an electronic classroom platform for providing educational material, discussions, announcements, assignments, • e-mail communication, • use of projectors during lectures, • use of software packages for simulation development • use of software packages for control of industrial systems • use of software packages for neural network control, fuzzy control, metaheuristic control and other artificial intelligence control methods • use of software packages to collect and exchange data among industrial subsystems
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non- directed study according to the principles of the ECTS*	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure*	The evaluation of postgraduate students and their performance in the course takes place at the end of each semester with written or oral examinations or assignments throughout the semester or can

Activity	*Semester Workload*
Lectures	39
Literature study & analysis	70
Project / Essay writing	91
Course Total	200

Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	be based on intermediate progress exams, written assignments, laboratory exercises or a combination of all the above. The method of evaluation is defined by the instructor of the course and announced to the students. The language for written and oral examinations is the same with that used for teaching. The assignments essays may be written in Greek and/or English language. When conducting written or oral examinations as assessment methods, the integrity of the procedure must be ensured. Scoring is done on a scale of 0-10. The results of the examinations are announced by the instructor and sent to the Secretariat of the Postgraduate Program within four weeks at the latest from the examination of the course. The participation rate of exercises, assignments, etc. The final grade of the course is determined by the course instructor and announced to students at the beginning of the semester. Alternative assessment methods may be applied, such as the conduct of written or oral examinations using electronic means, provided that the integrity of the evaluation process is ensured and the provisions of the relevant regulations of the MSc are met. Alternative methods may also be applied for the assessment of students with disabilities and special educational needs following a decision of the Board of Directors and the recommendation of the head of the Department for Disabled Persons and taking into account the relevant instructions of the Accessibility Unit for Students with Disabilities.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. A. Mellit and S. Kalogirou, Handbook of Artificial Intelligence Techniques in Photovoltaic Systems: Modeling, Control, Optimization, Forecasting and Fault Diagnosis, Elsevier Science, 2022.
2. B. Wittenmark, K-E Årzén & K. J. Åström, Computer Control: An Overview, International Federation of Automatic, 2002.
3. C. J. Harris, C. G. Moore and M. Brown, Intelligent Control: Aspects of Fuzzy Logic and Neural Nets, World Scientific, 1993.
4. E. J. González, L. Acosta Sánchez and A. F. Hamilton Castro (eds), Artificial Intelligence Resources in Control and Automation Engineering, Bentham Books, 2011.
5. F. Lamb, Industrial Automation: Hands On, McGraw Hill, 2013.
6. J. Ron Leigh, Artificial Intelligence and Automatic Control, Lulu Press Inc, 2005.
7. K. G. Vamvoudakis, Y. Wan, F. L. Lewis and D. Cansever (eds), Handbook of Reinforcement Learning and Control, Springer International Publishing, 2021.
8. L. Boullart, R. A. Vingerhoeds and A. Krijgsman (eds), Application of Artificial Intelligence in Process Control: Lecture Notes Erasmus Intensive Course, Elsevier Science, 1992.
9. P. Tatjewski, Advanced Control of Industrial Processes: Structures and Algorithms, Springer London, 2006.
10. P. Zhang, Advanced Industrial Control Technology, William Andrew, 2010.
11. R. Shariff, Real-time Artificial Intelligence Control and Optimization of a Full-scale WTP, Awwa Research Foundation, 2006.
12. S. Manesis and G. Nikolakopoulos, Introduction to Industrial Automation, CRC Press, 2018.
13. S.G. Tzafestas and H. B. Verbruggen (eds), Artificial Intelligence in Industrial Decision Making, Control and Automation, Springer Netherlands, 2012.

14. X. Su, Y. Wen, Y. Yang and P. Shi, Intelligent Control, Filtering and Model Reduction Analysis for Fuzzy-Model-Based Systems, Springer International Publishing, 2021
15. Y. P. Kondratenko, V. Kreinovich, W. Pedrycz, A. Chikrii and A. M. Gil-Lafuente, Artificial Intelligence in Control and Decision-making Systems: Dedicated to Professor Janusz Kacprzyk, Springer Nature Switzerland, 2023.
16. Y.-Z. Lu, Industrial Intelligent Control: Fundamentals and Applications, John Wiley & Sons, 1996.
17. Yimin Zhou, Chen Qiao, Lianghong Wu and Huiyu Zhou (eds), Intelligent Control and Applications for Robotics, Frontiers Media SA, 2022.
18. Φ. Κουμπουλής, Βιομηχανικός Έλεγχος, Εκδόσεις Νέων Τεχνολογιών, 1999.
19. R.-E. King, Βιομηχανικός Έλεγχος, Παπασωτηρίου, 1996

- *Relative academic journals:*

1. Artificial Intelligence Review, Springer.
2. Automatica, International Federation of Automatic Control, Elsevier.
3. Foundations and Trends in Machine Learning, Now Publishers Inc.
4. International Journal of Systems Science, Taylor and Francis.
5. Journal of Process Control, International Federation of Automatic Control, Elsevier.
6. Journal of the Franklin Institute, Elsevier.
7. Systems and Control Letters, Elsevier.
8. Transactions of Neural Networks and Learning Systems, , Institute of Electrical and Electronics Engineers.
9. Transactions on Automation Science and Engineering, Institute of Electrical and Electronics Engineers.
10. Transactions on Fuzzy Systems, Institute of Electrical and Electronics Engineers.
11. Transactions on Industrial Informatics, Institute of Electrical and Electronics Engineers.
12. Transactions on Pattern Analysis and Machine Learning, Institute of Electrical and Electronics Engineers.
13. Transactions on Systems, Man, and Cybernetics: Systems, Institute of Electrical and Electronics Engineers.
14. Transactions on Automatic Control, Institute of Electrical and Electronics Engineers.
15. Transactions on Control Systems Technology, Institute of Electrical and Electronics Engineers