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	**007**	**SEMESTER**	2nd
COURSE TITLE	Industrial Cyber-Physical 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.dind.uoa.gr/programma/mathimata/b_examino/biomichanika_kybernofysika_systimata/		

(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 applications of cyber-physical systems in modern industrial units, so as to acquire the theoretical and technological background in the field. Upon successful completion of the course, students will be able to:

• Model the integrated physical and cyber-physical elements.

• Understand the operating principles of distributed industrial systems and large-scale systems, resulting from the interconnection and interoperability among the individual subsystems.

• Implement and apply tools satisfying safe communication among the subsystems.

• Develop, implement, and apply systems that detect and identify cyber-attacks.

• Design and implement supervisory systems that improve resilience and robustness of cyber-physical systems.

• Design and implement supervisory systems that maintain interoperability of subsystems and comply with quality standards in industrial cyber-physical systems.

• Exploit all above skills to implement efficient industrial cyber-physical 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, with the use of the necessary technology
Adapting to new situations Decision-making
Working independently Team work
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

Working in an international environment Working in an interdisciplinary environment Production of new research ideas	*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

Integration of physical and cyber components. Distributed and Large-Scale Industrial Systems. Interconnection and interoperation of the Individual Subsystems. Data exchange among subsystems. Reconfigurable industrial processes. Flexible manufacturing processes. Modelling layers of cyber-physical systems. Layers of distributed and centralized control. Analysis of cyber-attacks in sensors, actuators, and interconnections. Attack detection and identification. Soft Sensors. Observers. Design and Development of Supervisors leading to resilient cyber-physical systems. Robustness and Reliability of industrial Cyber-Physical Systems. Interoperability and quality standards on Industrial Cyber-Physical Systems.

(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 producing • use of software packages for distributed and centralized control, • use of software packages for implementation of software sensors / observers, • use of software packages to collect and exchange data among industrial subsystems and industrial devices of various technologies.
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* *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,*	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 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

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

laboratory work, clinical examination of patient, art interpretation, other *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	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. G. Kavets, A. A. Bolshakov and M. V. Shcherbakov (eds), Cyber-Physical Systems: Industry 4.0 Challenges, Springer International Publishing, 2019.
2. A. G. Kravets, A. A. Bolshakov and M. V. Shcherbakov (eds), Cyber-Physical Systems: Digital Technologies and Applications, Springer International Publishing, 2021.
3. A. Romanovsky and F. Ishikawa (eds), Trustworthy Cyber-Physical Systems Engineering, CRC Press, 2016.
4. D. B. Rawat, J. J. P.C. Rodrigues and I. Stojmenovic (eds), Cyber-Physical Systems: From Theory to Practice, CRC Press, 2015.
5. D. Lacamera, Embedded Systems Architecture, PACKT Publishing, 2018
6. E. A. Lee και S. A. Seshia, Introduction to Embedded Systems - a Cyber-physical Systems Approach, 2nd ed., MIT Press, 2017
7. G. R. Karpagam, B. Vinoth Kumar, J. Uma Maheswari and X.-Z. Gao (eds), Smart Cyber Physical Systems: Advances, Challenges and Opportunities, CRC Press, 2020.
8. H. Song, D. B. Rawat, S. Jeschke and C. Brecher (eds), Cyber-Physical Systems: Foundations, Principles and Applications, Elsevier Science, 2016.
9. H. Song, G. A. Fink, S. Jeschke, Security and Privacy in Cyber-Physical Systems: Foundations, Principles, and Applications, Wiley, 2017.
10. I. Papaefstathiou and A. Hatzopoulos (eds), Heterogeneous Cyber Physical Systems of Systems, River Publishers, 2022.
11. K. P. Sharma, L. K. Awasthi, M. Mangla, N. Sharma and R. Kumar (eds), Cyber-Physical Systems: A Comprehensive Guide, CRC Press, 2022.
12. K. Siozios, D. Soudris and E. Kosmatopoulos, CyberPhysical Systems: Decision Making Mechanisms and Applications, River Publishers, 2022.
13. M. A. Al Faruque and A. Canedo (eds), Design Automation of Cyber-Physical Systems, Springer International Publishing, 2019.
14. M. Wolf, Computers as Components - Principles of Embedded Computing System Design, 4th ed., Morgan Kaufmann, 2016.
15. R. Alur, Principles of Cyber-physical Systems, MIT Press, 2015
16. R. Rajkumar, D. de Niz and M. Klein, Cyber-Physical Systems, Pearson Education, 2016.

17. S. Ali, T. Al Balushi, Z. Nadir, O. K. Hussain, Cyber Security for Cyber Physical Systems, Springer International Publishing, 2018.
18. S. Guo and D. Zeng (eds), Cyber-Physical Systems: Architecture, Security and Application, Springer International Publishing, 2018.
19. W. M. Taha, A.-E. M. Taha and J. Thunberg, Cyber-Physical Systems: A Model-Based Approach, Springer International Publishing, 2020.

- Relative academic journals:

1. Cyber-Physical Systems, Taylor & Francis.
2. IET Cyber-Physical Systems: Theory & Applications, The Institution of Engineering and Technology.
3. Internet of Things and Cyber-Physical Systems, STM publishers – China Science Publishing & Media and Elsevier – KeAi.
4. Transactions on Cyber-Physical Systems, Association on Computing Machinery.
5. Transactions on Industrial Cyber-Physical Systems, Institute of Electrical and Electronic Engineers.
6. International Journal of Cybernetics and Cyber-Physical Systems, Inderscience Publishers.
7. International Journal of Cyber-Physical Systems, IGI Global.