ROMANIAN ACADEMY - SCOSAAR

DOCTORAL SCHOOL of ENGINEERING SCIENCES, MECHANICS and COMPUTERS (SD-SIMC)

DISCIPLINE SHEET

Discipline name: Modeling, simulation and real-time control of mechatronic systems
Owner of course activities: Luige Vlădăreanu
Study year: 2024

Number of hours per week/Check/Credits		
Course	**Course**	**Credite**
2	Exam	15

A. THE COURSE OBJECTIVES (The objectives are formulated in terms of professional skills):

The general discipline objective	• Knowing and mastering the general principles of robot kinematics and dynamics • Acquiring the necessary knowledge for modelling robot kinematics and dynamics in applications and robotics design using basic concepts • Applications are made that facilitate the analytical and numerical modelling of the behaviour of complex mechatronic chains. • Development of general routines for robotic control and simulation, using the concepts of kinematics and dynamics learned
Specific objectives:	• Creating the skills to identify the typical situations of each method studied, to understand and correctly apply the theoretical and practical principles • The ability to use the principles of dynamic robot modeling, movement kinematics and robot trajectory planning, the fundamentals of monitoring and controlling mechatronic systems equipped with artificial vision - concepts, development, modeling, etc. • The possibility to comparatively evaluate different modeling methods and algorithms for the same problem and to be able to choose the best ones, for each situation in reality.

B. TERMS (where applicable)

course implementation	• Providing an optical projector (video projector) together with all related accessories (power cables, data and video signal, remote control) • Access to WOS

C. SPECIFIC ACCUMULATED COMPETENCES (Regards the competencies provided by the study program of which the discipline is a part)

Professional skills	• Deep knowledge of modelling and identification of mechatronic processes, modelling and image processing, image representation

	and their properties, image segmentation and shape representation, object modelling and recognition • The ability to independently use the principles of modelling and simulation methods in motion control, simulation of tracking methods, simulation of automatic motion control using visual information (visual servoing), three-dimensional vision and motion analysis, modelling and simulation in camera positioning control smart videos, etc. /
Transversal skills	• Adaptation to new technologies, professional and personal development, through continuous training using printed documentation sources, specialized software and electronic resources in Romanian and, at least, in one language of international circulation • The knowledge and skills acquired in this discipline will form the basis of future scientific and didactic research activities

A. COURSE CONTENT

a) Course

Chapter	Content	No. hours
1.	Real-time control in solid mechanics - concepts, development, modeling, validation	**8**
2.	Modeling, simulation and real-time control of mechanical systems	**7**
3.	Real-time control of multiple processes in distributed and decentralized structures	**7**
4.	The architecture of real-time control systems in the decentralized and distributed structure	**6**
	Total ore	**28**

B. EVALUATION (The methods, forms of evaluation and their weighting in establishing the final grade are specified. The minimum performance standards are indicated, related to the competencies defined in point **A. Discipline Objectives**)

Tip activitate	Criterii de evaluare	Metode de evaluare	Pondere din nota finală
Course	Knowledge acquired	Written exam	55%
Seminar	Activity	Case studies presented	25%
Laboratory	Acquired experimental knowledge	The results of laboratory experiments	20%
The results of the discipline evaluation are expressed by the following qualifications: "*Very good"; "Good"; "Satisfactorily"; "Unsatisfactory*". The grades "*Very good", "Good*" and "*Satisfactory*" allow the doctoral student to obtain the credits.			

F. EVALUAMETHODOLOGICAL REMARKS

Course: The teaching is based on the method of oral lectures and active dialogue with the students, supported by the presentation of illustrative examples and applications, or for recording the answers given to the students to their questions, but also on the use of the video projector to achieve the optimal conditions for direct communication with the students and of their active mobilization. The methods of communication with students are the expository method and the problematization method, both used head-on. Seminar and laboratory: Development of general routines for robotic modelling, with the idea of easy construction by hardware/software designers of a specific library. The types of exercises and problems covered in the seminar follow the lines of the course taught.

G. CORROBRATION OF THE DISCIPLINE CONTENTS WITH THE EXPECTATIONS OF THE REPRESENTATIVES OF THE EPISTEMIC COMMUNITY, PROFESSIONAL ASSOCIATIONS AND REPRESENTATIVE EMPLOYERS FROM THE FIELD RELATED TO THE PROGRAM

- The discipline provides a wide fund of fundamental and practical knowledge regarding the application of basic knowledge, concepts and methods regarding the architecture of robotic systems and the control of robotic systems.
- Ability to select and browse bibliographic sources
- Ability to learn new concepts by combining and referencing existing theoretical bases
- Ability to work in a team for a software project with interconnected tasks
- The ability to independently select and go through didactic materials external to the course

H. BIBLIOGRAPHY

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2. Siciliano, B., Sciavicco, L., Villani, L., & Oriolo, G. (2009). Mobile robots. Robotics: Modelling, Planning and Control, 469-521.
3. Lynch, K. M., & Park, F. C. (2017). Modern robotics. Cambridge University Press.
4. Kagan, E., Shvalb, N., & Ben-Gal, I. (Eds.). (2019). Autonomous mobile robots and multi-robot systems: Motion-planning, communication, and swarming. John Wiley & Sons.
5. Corke, P. I., & Khatib, O. (2011). Robotics, vision and control: fundamental algorithms in MATLAB (Vol. 73, p. 2). Berlin: Springer.
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7. Choset, H., Lynch, K. M., Hutchinson, S., Kantor, G. A., & Burgard, W. (2005). Principles of robot motion: theory, algorithms, and implementations. MIT press.
8. Vladareanu, L., Vladareanu, V., Yu, H., Wang, H., & Smarandache, F. (2019). Robot advanced intellectual control developed through flexible intelligent portable platform. Infinite Study.
9. Mason, M. (2001). Mechanics of Robotic Manipulation (Intelligent Robotics and Autonomous Agents Series).
10. B. Roffel, B.H.L. Betlem, Advanced Practical Process Control, 309 pag, Editura Springer, ISBN 3-540-40480-5.
11. V. Damic, J. Montgomery, Mechatronics by Bond Graphs, 448 pag, Editura Springer, ISBN 3-540-42375-3
12. Salvatore Pennacchio, Editor, International Society for Advanced Research, Emerging Technologies, Robotics and Control Systems Volume 1, Universita degli Studi Palermo, Italy, ISBN: 978-88-901928-1-4.

Course owner	Doctoral School Director
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