SYLLABUS
Academic year 2025-2026

Dean,
Prof. dr. eng. Vasile-Ion Manta

1. Program data

1.1 Higher education institution	"Gheorghe Asachi" Technical University of Iași
1.2 Faculty	Automatic Control and Computer Engineering
1.3 Department	Computers
1.4 Field of studies	Computers and Information Technology
1.5 The cycle of studies[1]	Master
1.6 Study program	Artificial Intelligence

2. Subject data

2.1 Name of the subject / Code				**Multiagent Systems** (*Sisteme multi-agent*) / **AI.201**			
2.2 Course coordinator				Prof. dr. eng. Florin Leon			
2.3 Application instructor				Lect. dr. eng. Marius Gavrilescu			
2.4 Year of study[2]	2	2.5 Semester[3]	3	2.6 Type of assessment[4]	exam	2.7 Type of subject[5]	DS

3. Estimated total time of daily activities (hours per semester)

3.1 Number of hours per week	4	3.2 lectures	2	3.3a sem.		3.3b laboratory	1	3.3c project	1
3.4 Total hours in curriculum[6]	56	3.5 lectures	28	3.6a sem.		3.6b laboratory	14	3.6c project	14

Distribution of the time fund[7]	No. hours
Study by textbook, course support, bibliography and notes	40
Additional documentation in the library, on specialist electronic platforms and in the field	30
Preparation of seminars/labs/projects, assignments, reports and portfolios	20
Tutorial[8]	
Examinations[9]	4
Other activities:	

3.7 Total hours of individual study[10]	94
3.8 Total hours per semester[11]	150
3.9 Number of credits	6

4. Prerequisites (where applicable)

4.1 curriculum[12]	
4.2 competences	

5. Conditions (where applicable)

5.1 conducting the lectures[13]	• Blackboard, video projector
5.2 conducting the seminar / laboratory / project[14]	• Laboratory room with computers and Internet access • The Visual Studio programming environment (academic license)

6. Specific competences accumulated[15]

		Number of credits assigned to the subject[16]: **6**	Distribution of credits per competences[17]
Professional competences	CP1	Knowledge of advanced concepts of computer science and information technology and the ability to work with these concepts.	1
	CP2	Scientific and practical research in the field of artificial intelligence.	1.1
	CP3	Problem solving using artificial intelligence methods and techniques.	1.1
	CP4	Design and development of artificial intelligence systems.	1.1
	CP5	Utilization of artificial intelligence tools and technologies.	1
	CP6		
	CPS1		
	CPS2		
Transversal competences	CT1	Legislation compliant application of the intellectual property rights and of the principles, norms and values of the professional ethics code within their own strategies for rigorous, effective and responsible work.	0.1
	CT2	Application of communication techniques and effective group work; developing empathic interpersonal communication skills and assuming leadership roles/functions in a multi-specialized team.	0.3

	CT3	Creating opportunities for continuous training and the effective utilization of learning resources and techniques for personal development.	0.3
	CTS		

7. Objectives of the subject (resulting from the grid of specific competences accumulated)

7.1 General objective of the subject	Understanding and possibility of practical application of knowledge specific to multiagent systems
7.2 Specific objectives	The goal of this course is to introduce the general concepts of multiagent systems, the ways in which agents can interact, cooperate and be coordinated to solve problems by searching for solutions in a distributed manner

8. Contents

8.1 Course[18]	Teaching methods[19]	Remarks
1. Introduction to the field of agents (2h) Agents; Intelligent agents; Mobile agents; Agent applications ***2. Agent architectures (I) (2h)*** Abstract Architectures; Logic-Based Architectures; Metatem; Reactive Architectures; Subsumption Architectures ***3. Agent architectures (II) (2h)*** BDI architecture; Applications of PRS; Layered architectures ***4. Game theory (I) (2h)*** Zero-sum games with two agents: Dominance; Pure and mixed minimax equilibrium; Matrix games ***5. Game theory (II) (3h)*** General sum games with two agents; Pure and mixed Nash equilibrium; Cooperative games; Game representation in characteristic form; The core; Shapley value; Nucleolus ***6. Game theory (III) (1h)*** Sequential games: Game representation in extended form, Transformation into normal form, Zermelo's Algorithm (minimax); Informational sets; Partial information games ***7. Inter-agent communication (2h)*** Types of communication in multiagent systems; Speech acts theory; Communication languages for agents; Ontologies ***8. Search algorithms for multiagent systems (2h)*** Search in non-deterministic environments; Search in partially observable environments; Online search in unknown environments: LRTA* and RTA* algorithms; Search in dynamic environments ***9. Auction and voting protocols (2h)*** Types of auctions; Auction strategies; Voting protocols; Paradoxes; Arrow's impossibility theorem; Strategic manipulation of votes; Gibbard-Satterthwaite theorem ***10. Negotiation protocols (2h)*** The negotiation problem; Game-theoretic approaches; Heuristic-based approaches; Argumentation-based approaches ***11. Mechanism design. Contract net protocol (2h)*** Mechanism design; Revelation principle of; Groves-Clarke and Vickrey-Clarke-Groves mechanisms; Contract net protocol; Task allocation; Concurrent contract nets ***12. Coordination methods. Agent Organizations (2h)*** Coordination through partial global planning (the TAEMS/GPGP model); Coordination through common intentions (the CDPS model); Coordination games; Agent organizations ***13. Learning in multiagent systems. Other multiagent system development frameworks (2h)*** Learning in multiagent systems: Repeated games (Fictitious play, Replicator dynamics, Evolutionarily stable systems); General theories for learning in multiagent systems; Other multiagent system development frameworks: Jade, NetLogo, Soar, Mason, Jason	Lectures with Powerpoint presentations, explanations and answers to questions	

14. Agent-based modelling and simulation (2h) Complex systems and emergent behaviour; Description and formulation of agent-based modelling: the ODD protocol; Applications of agent-based modelling; NetLogo simulations		
Course references: 1. Weiss, G., ed. (2016). *Multiagent Systems*, The MIT Press, Cambridge, Massachusetts. 2. Wooldridge, M. (2002). *An Introduction to MultiAgent Systems*, John Wiley & Sons. 3. Vidal, J.M. (2010). *Fundamentals of Multiagent Systems*. https://jmvidal.cse.sc.edu/papers/mas.pdf 4. Russell, S.J., Norvig, P. (2022). *Artificial Intelligence: A Modern Approach*, Prentice Hall, 4th edition. 5. Shoham, Y., Leyton-Brown, K. (2008). *Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations*, Cambridge University Press. 6. Ferber, J. (1999). *Multi-Agent Systems: An Introduction to Distributed Artificial Intelligence*, Addison-Wesley Professional. 7. Leon, F. (2006). *Intelligent Agents with Cognitive Capabilities*, Ed. Tehnopress, Iași. 8. Lin, F.O., ed. (2005). *Designing Distributed Learning Environments with Intelligent Software Agents*, Information Science Publishing. 9. Padgham, L., Winikoff, M. (2004). *Developing Intelligent Agent Systems: A Practical Guide*, Wiley Series in Agent Technology, Wiley. 10. Sugumaran, V., ed. (2007). *Application of Agents and Intelligent Information Technologies*, Advances in Intelligent Information Technologies, IGI Global.		
8.2a Seminar	Teaching methods[20]	Remarks
8.2b Laboratory	Teaching methods[21]	Remarks
1. Multiagent systems. The ActressMas library (2h) Definitions and general concepts; Presentation of the ActressMas library (Structure of classes, Agent class, Environment class, Execution flow of agents); Examples (Example 1: Counting agent, Example 2: Monitor agent with multiple worker agents); Applications ***2. Reactive agents (2h)*** Reactive agent architectures; The formal reactive model; Example: Exploratory agents (Non-collaborative agents, Optimization through collaboration between agents); Applications ***3. Auctions (2h)*** General presentation; Auction protocols (English, Blind, Dutch, Vickrey); Applications ***4. Negotiation protocols (2h)*** General aspects; Negotiation using game theory; Negotiation protocols (Monotonic concessions; Zeuthen strategy); Applications ***5. Contract Net Protocol (2h)*** General aspects; The Contract Net Protocol according to FIPA standards (Description, Exceptions to the standard protocol); Applications ***6. The prisoner's dilemma (2h)*** Fundamentals; The generalized version; The iterative version; Winning strategies; Applications ***7. The predator-prey model (2h)*** General description (The interaction between two populations, Exceptional situations); The Lotka-Volterra equations; Applications	General and individual explanations, individual computer work	
8.2c Project	Teaching methods[22]	Remarks
Individual project to design and implement a multiagent system. Stages: ***1. Clarification of the project topic. Establishing agent types and messages in the agent system (2h)*** ***2. Application design: Schematic representation of states and actions within the system with agents; establishing details related to user interaction (2h)*** ***3. Creating the hierarchy of classes related to the multiagent system. Establishing and implementing agent behaviours based on messages exchanged in the system. (2h)*** ***4. Implementation of the application based on the design made in the previous stages (4h)*** ***5. Elaboration of the documentation, verification of its correctness (4h)***		

Applications (laboratory / project) references:

1. Leon, F. (2023). *Multiagent Systems*. Lecture notes, http://florinleon.byethost24.com/curs_sma.html (or Moodle)
2. Leon, F. (2018). *ActressMas, A .NET Multiagent Framework*, http://florinleon.byethost24.com/actressmas , https://github.com/florinleon/ActressMas
3. Bigus, J.P., Bigus, J., (2001). *Constructing Intelligent Agents Using Java: Professional Developer's Guide*, 2nd edition, Wiley.
4. Knapik, M., Johnson, J. (1997). *Developing Intelligent Agents for Distributed Systems: Exploring Architectures, Techniques, and Applications*, Osborne McGraw-Hill.

9. Corroboration of the contents of the subject with the expectations of representatives of the epistemic community, professional associations and representative employers in the field related to the program[23]

The Multiagent Systems (MAS) course offers an essential understanding of collaborative artificial intelligence (AI) systems. By exploring how multiple AI entities interact, it cultivates expertise in designing intelligent systems that communicate, negotiate, and solve complex problems collectively. This course can enrich future professionals with the skills important for developing autonomous vehicles, smart infrastructure, and collaborative robotics. For the IT industry, MAS skills can help the creation of advanced, interconnected AI frameworks, driving advancements in areas like cybersecurity, network optimization, and efficient resource allocation.

10. Evaluation

<table>
<tr><th>Type of activity</th><th>10.1 Evaluation criteria</th><th colspan="2">10.2 Evaluation methods</th><th>10.3 Weight in the final grade</th></tr>
<tr><td rowspan="4">10.4a Exam</td><td rowspan="4">Acquired theoretical and practical knowledge (quantity, correctness, accuracy)</td><td>Periodic tests[24]:</td><td></td><td rowspan="4">50% (minimum 5)</td></tr>
<tr><td>Homework:</td><td></td></tr>
<tr><td>Other activities[25]:</td><td></td></tr>
<tr><td>Final evaluation:</td><td>100%</td></tr>
<tr><td>10.4b Seminar</td><td>Frequency/relevance of interventions or responses</td><td colspan="2">Record of interventions, portfolio of works (references, scientific summaries)</td><td></td></tr>
<tr><td>10.4c Laboratory</td><td>Knowledge of equipment, how to use specific tools; evaluation of tools or achievements, processing and interpretation of results</td><td colspan="2">• Practical demonstrations
• Oral answers
• Written questionnaires</td><td rowspan="2">50% (minimum 5)</td></tr>
<tr><td>10.4d Project</td><td>The quality of the completed project, the correctness of the project documentation, the justification of the chosen solutions</td><td colspan="2">• Self-assessment, presentation and/or defence of the project
• Critical evaluation of a project</td></tr>
<tr><td colspan="5">10.5 Minimum performance standard[26]: grade 5 in the exam and applications (the average between laboratory and project)</td></tr>
</table>

Date of completion,
4 December 2023

Signature of course coordinator,
Prof. dr. eng. Florin Leon

Signature of application instructor,
Lect. dr. eng. Marius Gavrilescu

Date of approval in the department,
7 December 2023

Director of department,
Assoc. prof. dr. eng. Andrei Stan

[1] *Bachelor / Master*
[2] *1-4 for Bachelor's, 1-2 for Master's*
[3] *1-8 for Bachelors, 1-3 for Masters*
[4] *Exam, colloquium or VP A/R – from the curriculum*
[5] *DF - fundamental subject, DID - subject in the field, DS - specialized subject or DC - complementary subject - from the education plan*
[6] *It is equal to 14 weeksx number of hours from point 3.1 (similar for 3.5, 3.6abc)*
[7] *The lines below refer to the individual study; the total is completed at point 3.7.*
[8] *Between 7 and 14 hours*
[9] *Between 2 and 6 hours*
[10] *The sum of the values on the previous lines, which refer to the individual study.*
[11] *The sum of the number of hours of direct teaching activity (3.4) and the number of hours of individual study (3.7); must be equal to the number of credits allocated to the subject (point 3.9)x 25 hours per credit.*
[12] *Mention the subjects that must be passed previously or equivalent*
[13] *Blackboard, video projector, flipchart, specific teaching materials, etc.*
[14] *Computing technique, software packages, experimental stands, etc.*

[15]*Competencies from the G1 and G1bis Grids of the study program, adapted to the specifics of the subject, for which credits are allocated (www.rncis.ro or the faculty website)*
[16] *From the education plan*
[17]*The credits allocated to the subject are distributed on professional and transversal competences according to the specifics of the subject*
[18]*Chapter and paragraph headings*
[19]*Exposition, lecture, blackboard presentation of the studied issue, use of video projector, discussions with students (for each chapter, if applicable)*
[20]*Discussions, debates, presentation and/or analysis of papers, solving exercises and problems*
[21]*Practical demonstration, exercise, experiment*
[22]*Case study, demonstration, exercise, error analysis, etc.*
[23]*The connection with other subjects, the usefulness of the subject on the labor market*
[24]*The number of tests and the weeks in which they will be held will be specified.*
[25]*Scientific circles, professional competitions, etc.*
[26]*The minimum performance standard from the competences grid of the study program is customized to the specifics of the subject, if applicable.*