COURSE SYLLABUS

Academic year 2024-2025

1. Programme Information

1.1. Higher education institution	Lucian Blaga University of Sibiu
1.2. Faculty	Faculty of Engineering
1.3. Department	Department of Computer Science and Electrical and Electronics Engineering
1.4. Field of study	Computer Science and Information Technology
1.5. Level of study[1]	Master
1.6. Programme of study/qualification	EMBEDDED SYSTEMS

2. Course Information

2.1. Name of course	Internet of Things			Code	ES.303.RO	
2.2. Course coordinator	Prof. Adrian FLOREA, PhD					
2.3. Seminar/laboratory coordinator	Sef lucr. dr. mat. Antoniu PITIC					
2.4. Year of study[2]	2	2.5. Semester[3]	3	2.6. Evaluation form[4]	E	
2.7. Course type[5]	O	2.8. The formative category of the course[6]			R	

3. Estimated Total Time

3.1. Course Extension within the Curriculum – Number of Hours per Week					
3.1.a. Lecture	3.1.b. Seminar	3.1.c. Laboratory	3.1.d. Project	3.1.e. Other	Total
1		1			**2**
3.2. Course Extension within the Curriculum – Total Number of Hours within the Curriculum					
3.2.a. Lecture	3.2.b. Seminar	3.2.c. Laboratory	3.2.d. Project	3.2.e. Other	Total[7]
14		14			**28**

Time Distribution for Individual Study[8]	**Hours**
Learning by using course materials, references and personal notes	6
Additional learning by using library facilities, electronic databases and on-site information	6
Preparing seminars / laboratories, homework, portfolios and essays	28
Tutorial activities[9]	4
Exams[10]	3

3.3. Total Individual Study Hours[11] (*$NOSI_{sem}$*)	**47**
3.4. Total Hours in the Curriculum (*$NOAD_{sem}$*)	**28**
3.5. Total Hours per Semester[12] (*$NOAD_{sem}$ + $NOSI_{sem}$*)	**75**
3.6. No. of Hours / ECTS	**25**
3.7. Number of credits[13]	**3**

4. Prerequisites (if needed)

4.1. Courses that must be successfully completed first (from the curriculum)[14]	Basic (undergraduate) courses in informatics (programming, algorithms, sensors, network).
4.2. Competencies	

5. Conditions (where applicable)

5.1. For course/lectures[15]	*Board, video projector, flipchart, specific teaching materials, online platforms*
5.2. For practical activities (lab/sem/pr/app)[16]	*Computing technology, software packages, online platforms*

6. Specific competencies acquired[17]

				Credits distribution by competencies[19]
		Number of credits assigned to the discipline[18]	3	
6.1. Professional competencies	PC11	design prototypes		1
	PC12	promote the transfer of knowledge		0.5
	PC14	test hardware		1
6.2. Transversal competencies	TC1	apply knowledge of science, technology and engineering		0.5

7. Course objectives (resulted from developed competencies)

7.1. Main course objective	The Internet of Things (IoT) represents an engineering development in which the Internet extends into the real world embracing everyday objects. Physical entities are no longer disconnected from the virtual world, but can be controlled remotely and can act as physical access points to Internet services. The Internet of Things is a new enhancement of the Internet which aims at enabling „Things" to be connected anytime (any context) at anyplace (anywhere) with anything (any device) and anyone using any path or network and any service or business. The vision of the Internet of Things (IoT) is a future where microprocessors and wireless radios are embedded into everyday objects, providing intelligent behavior to objects and enabling them to automatically and intelligently serve people in a collaborative manner. IoT is expected to revolutionize many areas of our lives, including healthcare, manufacturing, transportation, robotics, and agriculture. Engineers of all backgrounds and disciplines will be involved in the design of future IoT products for a diverse set of applications. The focus of this course is to explore the basic building blocks that make the Internet of Things possible, including the underlying core hardware components, basic input/output operations, wireless radio technologies, and sensing/actuation devices. We will discuss fundamental concepts of IoT systems and their use in a wide range of applications and also address various aspects of the wider IoT ecosystems such as security, privacy, and ethical considerations. The course will be a hands-on course with various skill building lab modules and projects. We will first learn the basics of Python programming and then work through various IoT components, such as sensing, actuation, and networking, using Raspberry Pi (and potentially Arduino) devices.
7.2. Specific course objectives	By the end of the course, a student this class will be able to demonstrate, among other things, the following: • Able to understand the application areas of IoT • An understanding of how microprocessors, sensors, and radio hardware are

	integrated into an embedded/IoT hardware platform. • To understand the architecture of Internet of Things (IoT). • Get hands-on experience of open hardware. • To program the embedded hardware with Python. • Get knowledge of Communication Technologies. • To develop Applications for data visualization.

8. Content

8.1. Lectures[20]		**Teaching methods**[21]	**Hours**
Lecture 1	Engineering IoT! What is the Internet of Things? And why should you care? Presenting keynotes, TedX lectures regarding IoT's applicability.	Exposition, lecture, use of video projector, discussions with students	2
Lecture 2	Smart city challenges! Cross fertilization of computer science domains (Computer Vision, Microprocessors and Embedded Systems, Networking, Web Design) in the development of applications aiming societal challenges. Digital design skills for Factory of the Future!	Exposition, lecture, use of video projector, discussions with students	2
Lecture 3	The course structure, bibliography, activities schedule and grading system. Introduction to embedded systems. Moore's law and ubiquitous computers. What are embedded systems? Differences between processors of embedded systems and those of general-purpose systems.	Exposition, lecture, use of video projector, discussions with students	2
Lecture 4	What is IoT? Genesis. Definitions, characteristics. Introduction to IoT. IoT versus Embedded Systems.	Exposition, lecture, use of video projector, discussions with students	2
Lecture 5	Fundamentals of IoT, basic concepts, applications. IoT applicability. Basic IoT concepts & applications.	Exposition, lecture, use of video projector, discussions with students	2
Lecture 6	IoT Basic Architectures: Perception, Network & Application layers. Processing, IoT cloud, analytics, visualization. Industrial IoTs. Illustrate the application of IoT in Industrial Automation and identify Real World Design Constraints.	Exposition, lecture, use of video projector, discussions with students	2
Lecture 7	Final Review from taught lessons.	Board presentation of the studied topic, discussions with students	2
		Total lecture hours:	**14**

8.2. Practical activities (8.2.a. Seminar[22]/ 8.2.b. Laboratory[23]/ 8.2.c. Project[24])		**Teaching methods**	**Hours**
Act.1	**Workplace safety – Employees emotion recognition**: monitor a machine operator and detect the operator's emotional state. Send an alert if the operator is distracted or angry. **1. Introduction to Python & OpenCV:** • Presenting the objectives and structure of this laboratory • Downloading and installing PyCharm & Python • Installing OpenCV, NumPy, SciPy • Python vs C++ vs Java • Python language exercises • OpenCV usage	Practical demonstration, exercise	2
Act.2	**2. Face detection** • Face detection: theory • Detecting faces in images • Detecting faces in video sequences Project architecture setup	Practical demonstration, exercise	2
Act.3	**3. Supervised learning: Understanding classification algorithms** • Machine learning: classification problems • SciKit-learn discussions Classification exercises	Practical demonstration, exercise	2
Act.4	**4. Recognizing facial emotions** • Understanding facial expressions and emotions • Recognize human emotions from live video sequences • Learning a classifier to recognize facial emotions from a dataset • Tuning the classifier parameters to increase accuracy • Live face emotion recognition system	Practical demonstration, exercise	2
Act.5	**Sibiu – Smart City Modelling** **1. Modeling Tools presentation and theory about models and limitations and application area** • Introduction to ADOxx; Platform demonstration and Hands-On following "Hello World" sample • Demonstration of different Scenarios of implementation of modeling • Modeling Language Implementation on ADOxx • Model implementation and walk through of all parts of modeling language development • Homework: Implement 2 Models in ADOxx **2. Smart City** • Project presentation • Area of application and problem to solve • Implement Modeling Language • Models simulation • Classes • Testing the Modeling Language • Class Attributes	Practical demonstration, exercise	2
Act.6	**Automation of assembly lines assisted by a robotic arm and a mobile robot** • Simulation of assembly line automation using modeling languages. • Handling a robotic arm and a mobile robot. • Creating the model to solve the problem. • Writing the code to solve the problem. • Prototype to simulate the AGVs in logistic processes. • Using Bee-Up as a tool for the CPS part and the Flowchart	Practical demonstration, exercise	2

	as a working method, and for the Design Thinking and Conceptual Modeling parts the Scene2Model http://digifof.omilab.ulbsibiu.ro/static/presentations/Octavian.mp4		
Act.7	**Parking of a mobile robot using modeling languages** • Project presentation • Integration with/in Smart City project • Implement and test the Modeling Language • model the Mobile Robot to park at a specific place, and also at the first parking space it finds available • Using Bee-Up as a tool for the CPS part and the Flowchart as a working method	Practical demonstration, exercise	2
		Total seminar/laboratory hours:	14

9. Bibliography

9.1. Recommended Bibliography	Banciu, C., Florea, A., & Bogdan, R. (2024). Monitoring and Predicting Air Quality with IoT Devices. Processes, 12(9), 1961.
	Florea, A., Popa, D. I., Morariu, D., Maniu, I., Berntzen, L., & Fiore, U. (2024). Digital farming based on a smart and user-friendly IoT irrigation system: A conifer nursery case study. IET Cyber-Physical Systems: Theory & Applications, 9(2), 150-168.
	https://arxiv.org/ftp/arxiv/papers/1611/1611.03340.pdf
	https://www3.nd.edu/~cpoellab/teaching/cse34468/schedule.html
	Joseph A. Fisher, Paolo Faraboschi, Cliff Young, Embedded Computing: A VLIW Approach to Architecture, Compilers and Tools, 1st Edition, Morgan Kaufmann, 2005.
	Wayne Wolf, High-Performance Embedded Computing: Architectures, Applications, and Methodologies, 1st Edition, Morgan Kaufmann, 2007.
9.2. Additional Bibliography	https://www.plex.com/content/plex/en_us/blogs/what-small-manufacturers-need-to-know-about-industrial-iot-190725.html
	https://www.intel.com/content/www/us/en/embedded/products/apollo-lake/changing-the-world-through-iot-technology-video.html
	https://www.intel.com/content/www/us/en/manufacturing/videos/foundation-for-industrial-iot-solutions-video.html
	https://www.youtube.com/watch?v=_AlcRoqS65E

10. Conjunction of the discipline's content with the expectations of the epistemic community, professional associations and significant employers of the specific study program[25]

Students will acquire research skills preparing them for the transition to a new stage of doctoral admission. It is carried out through regular discussions in a formal and informal setting with the representatives of the profile companies.

11. Evaluation

Activity Type	11.1 Evaluation Criteria	11.2 Evaluation Methods		11.3 Percentage in the Final Grade	Obs.[26]
11.4a Exam / Colloquy	• Theoretical and practical knowledge acquired (quantity, correctness, accuracy)	Tests during the semester[27]:	10%	60%	CPE
		Homework:	20%		
		Other activities[28]:	10%		
		Final evaluation:	60%		
11.4c	• Knowledge of the	• Written questionnaire		40%	CPE,

Laboratory	equipment, how to use specific tools; evaluation of tools, processing and interpretation of results	• Oral response • Laboratory notebook, experimental works, reports, etc. • Practical demonstration		CEF
11.5 Minimum performance standard[29] The final assessment will include written work consisting of (partial) grid tests and problems. • Knowledge, understanding and explaining the basics of evolutionary computing. • Constant interest to acquire discipline. • Partial fulfilment (50%) of homework, essays and tests given during the semester.				

The Course Syllabus will encompass components adapted to persons with special educational needs (SEN – people with disabilities and people with high potential), depending on their type and degree, at the level of all curricular elements (skills, objectives, contents, teaching methods, alternative assessment), in order to ensure fair opportunities in the academic training of all students, paying close attention to individual learning needs.

Filling Date: 09.09.2024
Department Acceptance Date: 16.09.2024

	Academic Rank, Title, First Name, Last Name	Signature
Course Teacher	Prof. Adrian FLOREA, PhD	
Study Program Coordinator	Prof. Arpad GELLERT, PhD	
Head of Department	Assoc. Prof. Radu George CREȚULESCU, PhD	
Dean	Prof. Maria VINȚAN, PhD	

[1] *Bachelor / Master*
[2] *1-4 for bachelor, 1-2 for master*
[3] *1-8 for bachelor, 1-3 for master*
[4] *Exam, colloquium or VP A/R - from the curriculum*
[5] *Course type: R = Compulsory course; E = Elective course; O = Optional course*
[6] *Formative category: S = Specialty; F = Fundamental; C = Complementary; I = Fully assisted; P = Partially assisted; N = Unassisted*
[7] *Equal to 14 weeks x number of hours from point 3.1 (similar to 3.2.a.b.c.)*
[8] *The following lines refer to individual study; the total is completed at point 3.37.*
[9] *Between 7 and 14 hours*
[10] *Between 2 and 6 hours*
[11] *The sum of the values from the previous lines, which refer to individual study.*
[12] *The sum (3.5.) between the number of hours of direct teaching activity (NOAD) and the number of hours of individual study (NOSI) must be equal to the number of credits assigned to the discipline (point 3.7) x no. hours per credit (3.6.)*
[13] *The credit number is computed according to the following formula, being rounded to whole neighbouring values (either by subtraction or addition*

$$No.credits = \frac{NOCpSpD \times C_C + NOApSpD \times C_A}{TOCpSdP \times C_C + TOApSdP \times C_A} \times 30\ credits$$

Where:

- NOCpSpD = Number of lecture hours / week / discipline for which the credits are calculated
- NOApSpD = Number of application hours (sem./lab./pro.) / week / discipline for which the credits are calculated
- TOCpSdP = Total number of course hours / week in the Curriculum
- TOApSdP = Total number of application hours (sem./lab./pro.) / week in the Curriculum
- C_C/C_A = Course coefficients / applications calculated according to the table

Coefficients	**Course**	**Applications (S/L/P)**
Bachelor	2	1
Master	2,5	1,5
Bachelor - foreign language	2,5	1,25

[14] *The courses that should have been previously completed or equivalent will be mentioned*
[15] *Board, video projector, flipchart, specific teaching materials, online platforms, etc.*
[16] *Computing technology, software packages, experimental stands, online platforms, etc.*
[17] *Competences from the Grids related to the description of the study program, adapted to the specifics of the discipline*
[18] *From the curriculum*
[19] *The credits allocated to the course are distributed across professional and transversal competences according to the specifics of the discipline*
[20] *Chapter and paragraph titles*
[21] *Exposition, lecture, board presentation of the studied topic, use of video projector, discussions with students (for each chapter, if applicable)*
[22] *Discussions, debates, presentations and/or analyses of papers, solving exercises and problems*
[23] *Practical demonstration, exercise, experiment*
[24] *Case study, demonstration, exercise, error analysis, etc.*
[25] *The relationship with other disciplines, the usefulness of the discipline on the labour market*
[26] *CPE – Conditions Exam Participation; nCPE – Does Not Condition Exam Participation; CEF - Conditions Final Evaluation; N/A – not applicable*
[27] *The number of tests and the weeks in which they will be taken will be specified*
[28] *Scientific circles, professional competitions, etc.*
[29] *The minimum performance standard in the competence grid of the study program is customized to the specifics of the discipline, if applicable*