SYLLABUS

1. Program Information

1.1 Higher education institution	Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Automation and Computer Science
1.3 Department	Department of Automation
1.4 Field of study	Automation, Applied Informatics and Intelligent Systems
1.5 Cycle of studies	Bachelor
1.6 Study Programme/Qualification	Intelligent Automation Systems (dual, in English language)
1.7 Form of education	IF – full-time education
1.8 Course code	28.20

2. Course information

2.1 Course title	**Embedded Systems**					
2.2 Course lecturer	*Prof. Eng. Silviu FOLEA, PhD – Silviu.Folea@aut.utcluj.ro*					
2.3 Seminar / Laboratory / Project Lecturer	*Ing. Eliza Olariu (Emerson)*					
2.4 Year of study	2	2.5 Semester	2	2.6 Type of assessment		E
2.7 Course status	Formative category *(DF, DS, DC)*					DS
	Optionality *(DOB, DOP, DFac)*					DOP

3.Total estimated time

3.1 Number of hours per week	4	of which:	HEI	Lecture	2	Seminar	0	Laboratory	0	Project	0
			CO		0		0		2		0
3.2 Number of hours per semester	56	of which:	HEI	Lecture	28	Seminar	0	Laboratory	0	Project	0
			CO		0		0		28		0

3.3 Distribution of time allocation (hours per semester) for:	HEI	CO
(a) Study based on textbook, course support, bibliography, and notes	10	10
(b) Additional documentation in library, specialized electronic platforms, and fieldwork	10	10
(c) Preparation of seminars/laboratories, assignments, papers, portfolios and essays	0	20
(d) Tutoring	0	4
(e) Examinations	2	3
(f) Other activities:	0	0
3.4 Total individual study hours (sum (3.3(a)... 3.3(f)))	22	47
3.5 Total hours per semester (3.3+3.4)	50	75
3.6 Number of credits per semester	2	3

(HEI = Higher Education Institution, CO = Company)

4. Prerequisites (where applicable)

4.1 Curriculum Prerequisites	N/A
4.2 Competency Prerequisites	• Analog and digital signal acquisition system architectures, signal conditioning circuitry, signal generators, sensors and transducers, and industrial equipment programming

5. Conditions (where applicable)

5.1. Course Organization Conditions	• Room with computers, NI LabVIEW™ Real-Time, NI LabVIEW™ FPGA and equipment for hands-on applications.
5.2. Seminar / Laboratory / Project organization conditions	• Attendance is mandatory

6. Specific Competencies Acquired

Professional Competencies	• PC02 Analyse test data • PC08 Design automation components • PC09 Design prototypes • PC19 Prepare production prototypes • PC20 Record test data • PC26 Use information technology tools • PC30 Design control systems
Transversal Competencies	• TC01 Apply knowledge of science, technology and engineering • TC05 Interpret mathematical information

7. Learning outcomes

Knowledge:	• The student will be able to describe and explain the architecture and functionality of embedded systems, including NI CompactRIO™ and NI PXI™. • The student will be able to identify and classify hardware and software components of embedded systems used in industrial automation.
Skills:	• The student will be able to apply graphical programming techniques in NI LabVIEW™ for data acquisition, signal processing, and system control. • The student will be able to design and implement real-time applications and data communication interfaces in industrial embedded systems.
Responsibility and autonomy:	• The student will be able to work independently and in teams to develop, document, and evaluate embedded system applications. • The student will be able to demonstrate initiative and responsibility in applying embedded system solutions to industrial challenges.

8. Course Objectives

8.1 General objective of the course	• Understand the concept of virtual instrumentation, of industrial embedded systems.
8.2 Specific objectives	• Knowledge of NI LabVIEW™ specific programming techniques on Programmable Automation Controller and PXI industrial computers. Implementing programs using graphical programming. Benchmarks with industrial equipment.

9. Contents

9.1 Lectures	No. of hours	Teaching methods	Obs.
1. Introduction to embedded systems, features, requirements, and classifications.	2	Projector presentations	
2. Components of an embedded system, hardware, and software.	2		
3. Implementation, hardware, and software co-design.	2		
4. Reducing power consumption in dedicated systems.	2		

5. Energy harvesting by different methods: solar, vibration, thermal or RF.	2		
6. Introduction to NI CompactRIO™ systems, configuration in NI MAX™. Application architecture for NI CompactRIO™.	2		
7. Real-time controller, programming with NI LabVIEW™ Real Time.	2		
8. Real-time application performance testing.	2		
9. FPGA-type programmable reconfigurable systems. General methods for programming FPGAs.	2		
10. FPGA, programming with NI LabVIEW FPGA™. Fixed-point math function library for FPGA.	2		
11. Data transfer between platforms, synchronization. Types of variables. Communication between program loops in case of parallel execution on RT and FPGA.	2		
12. Industrial applications of the technologies presented, part I.	2		
13. Industrial applications of the technologies presented, part II.	2		
14. Industrial applications of the technologies presented, part III.	2		

Bibliography

1. National Instruments, „NI LabVIEW™ Real-Time for Academia Course", Course Software Version 2024, digital format.
2. Ed Lipiansky, "Embedded System Hardware for Software Engineers", McGraw Hill, 2012, Bibl. UTC-N 541.302.
3. Peter Marwedel, „Embedded System Design, Embedded Systems Foundations of Cyber-Physical Systems", Springer 2011, 2nd Edition, Bibl. UTC-N 535.862.
4. Peter Marwedel, „Embedded System Design", Springer, 2006, Bibl. UTC-N 530.333.
5. Tammy Noergaard, „Embedded Systems Arhitecture", Elsevier 2005, Bibl. UTC-N 519.447.
6. Arnold Berger, „Embedded Systems Design", CMP Books 2002, Biblioteca UTC-N 530.334.
7. Robert H. Bishop, National Instruments, "LabVIEW 2009 Student Edition", Prentice Hall, 2009, Bibl. UTC-N 536.027.

9.2 Seminar / laboratory / project	Hours HEI	Hours CO	Teaching methods	Obs.
1. Benchmarks for NI CompactRIO™ and PXI™ industrial computing systems.		2	Practical activities on the equipment, the development of software applications	
2. Measuring power consumption from the electrical network using NI CompactRIO™.		2		
3. Analog and digital signal generators using internal FPGAs on NI systems.		2		
4. Speed control of a DC motor using NI CompactRIO™.		2		
5. Measurement of battery energy capacity.		2		
6. Implementation and testing of digital filters on NI myRIO™ or NI CompactRIO™.		2		
7. Practical exam.		2		

Bibliography

1. Silviu Folea, „Embedded and reconfigurable systems programmable using LabVIEWTM", practical applications, UTPRESS, 2024, 76 pg., ISBN 978-606-737-710-1, online.
2. Ed Doering, „NI myRIO Project Essentials Guide", 2013 National Technology and Science Press, download the latest version at http://www.ni.com/myrio/project-guide.

10. Correlation of course content with the expectations of the epistemic community representatives, professional associations, and major employers in the field related to the program

The topics presented at this course are specialized ones; they are included in other universities' curricula. The NI LabVIEW™ graphical programming environment is used in industrial testing, measurement, and control applications.

11. Evaluation

Activity Type	**Evaluation criteria**	**Evaluation methods**	**Weight in final grade**
11.1 Lecture	Acquired theoretical knowledge	Written exam	50 %
11.2 Seminar/ Laboratory/Project	Acquired practical skills	Practical exam	50 %
11.3 Minimum Performance Standard			
Final exam >= 5 Lab grade >= 5 mandatory to be able to take the final exam 50% Final exam + 50% Lab Grade > 5			

Date of completion: 16.05.2025	Lecturers		Signature
	Course	Prof. Eng. Silviu FOLEA, PhD	

Date of approval by the Department of Automation Council 24.11.2025 _____ Date of approval by the Faculty of Automation and Computer Science Council 28.11.2025 _____	Director of the Department of Automation Prof. Eng. Honoriu VĂLEAN, PhD Dean Prof. Eng. Vlad MUREȘAN, PhD