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	TBD
1.7 Form of education	IF – full-time education
1.8 Course code	56.10

2. Course information

2.1 Course title	**System Testing for Control Engineering**				
2.2 Course lecturer	*Prof.dr.ing. Horia Hedesiu - Horia.Hedesiu@emd.utcluj.ro*				
2.3 Seminar / Laboratory / Project Lecturer	*Ing. Ciprian Iakab (Emerson)*				
2.4 Year of study	4	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	
			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	14	14
(b) Additional documentation in library, specialized electronic platforms, and fieldwork	14	8
(c) Preparation of seminars/laboratories, assignments, papers, portfolios and essays	14	0
(d) Tutoring	8	0
(e) Examinations	3	0
(f) Other activities:	0	0
3.4 Total individual study hours (sum (3.3(a)... 3.3(f)))	47	22
3.5 Total hours per semester (3.2+3.4)	75	50
3.6 Number of credits per semester	3	2

(HEI = Higher Education Institution, CO = Company)

4. Prerequisites (where applicable)

4.1 Curriculum Prerequisites	Fundamentals of Electrical Circuit Theory, Sensors, Embedded Systems, Electrical Measurement, Statistics
4.2 Competency Prerequisites	Knowledge of basic control engineering and electronics

5. Conditions (where applicable)

5.1. Course Organization Conditions	Lecture room equipped with projector, whiteboard, and internet access; availability of industrial testing standards and documentation.
5.2. Seminar / Laboratory / Project organization conditions	Access to: • NI PXI/PXIe modular testing systems, oscilloscopes, multimeters, logic analyzers, signal generators • DUT fixtures, sensor boards, embedded systems platforms • Software tools: LabVIEW, TestStand, NI FlexLogger, NI SystemLink, Python

	• Environmental testing equipment (thermal chamber, vibration stand – where applicable)

6. Specific Competencies Acquired

Professional Competencies	• PC02 Analyse test data • PC05 Conduct quality control analysis • PC07 Demonstrate disciplinary expertise • PC10 Develop electronic test procedures • PC11 Develop mechatronic test procedures • PC16 Monitor manufacturing quality standards • PC21 Report analysis results • PC26 Use information technology tools • PC28 Use testing equipment
Transversal Competencies	• TC01 Apply knowledge of science, technology and engineering • TC02 Think analytically • TC03 Demonstrate responsability

7. Learning outcomes

Knowledge:	The student will: • Understand principles, methodologies, and standards of electronic and mechatronic system testing. • Describe testing strategies (functional, in-circuit, boundary-scan, system-level) and their application in design, validation, and production. • Explain the operation and use of instrumentation such as oscilloscopes, logic analyzers, PXI systems, and automated test platforms. • Understand reliability concepts, environmental testing procedures, and test coverage optimization.
Skills:	The student will be able to: • Configure and operate test equipment, acquire signals, and perform analog/digital measurements. • Develop automated test procedures using LabVIEW, TestStand, or Python. • Analyze test data, identify faults, apply diagnostic techniques, and generate structured reports. • Interface with a DUT, design test plans from specifications, and evaluate compliance with requirements.
Responsibility and autonomy:	The student will: • Respect safety rules, ESD procedures, and standardized testing workflows. • Work independently on experimental setups and show initiative in configuring and debugging test systems. • Document testing activities responsibly and deliver clear, reproducible test results. • Collaborate constructively within teams during system-level testing and evaluation tasks.

8. Course Objectives

8.1 General objective of the course	Understand and master the modern testing techniques and technologies
8.2 Specific objectives	Ability to understand the functionalities of different electrical testing equipment, being prepared for:

	- Product testing and validation - Quality assurance and control - R&D and prototyping - Manufacturing engineering

9. Contents

9.1 Lectures	No. of hours	Teaching methods	Obs.
1. Introduction to Electronic Testing. Safety Procedures & Standards • Role of testing in design, production, and maintenance • Overview of test strategies: functional, in-circuit, boundary scan • Electrical safety • ESD (Electrostatic Discharge) precautions Testing standards: IPC, IEEE, ISO	2	Power Point presentations and computations	
2-3. Measurement Tools & Instrumentation. Analog & Digital Testing Techniques. NI Hardware • Oscilloscopes, multimeters, signal generators. Signal acquisition and conditioning • Logic analyzers, spectrum analyzers • Calibration procedures • Signal integrity analysis • Noise and distortion tests • Timing analysis for digital circuits NI PXI chassis and modules. Synchronization and triggering	4		
4. Fault Detection & Diagnosis. Fault Injection and Robustness Testing • Fault types: opens, shorts, component failure • Simulating real-world failures • Diagnostic flowcharts and troubleshooting strategies. Environmental stress testing (thermal, vibration)	2		
5. Automated Test Equipment (ATE). Automated Testing with LabVIEW • Test automation fundamentals • Overview of PXI, VXI, LXI platforms. Scaling up to complex testing systems • Programming automated tests (TestStand, LabVIEW, Python) Creating virtual instruments (VIs), Data logging, visualization, and analysis; Debugging and error handling	2		
6. What is a DUT? DUT Specifications & Test Requirements • Definitions and real-world examples • DUT in the context of design, validation, and production • Lifecycle of a DUT: from prototype to fielded product • Reading datasheets and design specs Translating functional requirements into test objectives	2		
7. Interfacing with the DUT. Stimulus and Response Testing • Electrical interfaces: analog, digital, RF, power	2		

• Mechanical fixtures and test jigs • Signal conditioning and protection circuits • Applying input signals and monitoring outputs • Functional testing vs. parametric testing • Timing, voltage, and frequency domain analysis				
8. DUT Test Coverage and Optimization • Code coverage vs. test coverage • Reducing test time without sacrificing quality • Statistical analysis of DUT performance	2			
9. Functional Testing, System-Level Testing • Power-on self-tests • Embedded diagnostics • I2C, SPI, UART, CAN, USB, or Ethernet • UI testing • Interoperability and integration testing	2			
10. In-Circuit Testing (ICT), Boundary Scan (JTAG), Parametric Testing • Check on individual components on a PCB without powering the full system • Testing of internal logic and memory without physical access Measurements of electrical parameters - voltage, current, resistance, and timing	2			
11. Environmental & Reliability Testing • Thermal, vibration, humidity stress testing • MTBF (Mean Time Between Failures), burn-in tests Simulating stress conditions	2			
12. Test Data Management & Reporting • NI Flexlogger. Use Cases and Applications • Using NI DIAdem or LabVIEW for data analysis Generating automated test reports	2			
13. NI SystemLink. IIoT in Testing • What is SystemLink? Connected Testing Systems. Assets Enterprise Applications. Large Testing Systems	2			
14. Intelligent Test Vision • AI/ML in Testing Industry • NI Nigel. Generating Automated Test. Industry Examples • How to improve quality and yield? • Future trends	2			

Bibliography:
1. National Instruments, *LabVIEW Core 1 (https://learn.ni.com/learning-paths/labview-core-1)*
2. National Instruments, *LabVIEW Core 2 (https://learn.ni.com/learning-paths/labview-core-2-course)*
3. National Instruments, TestStand Documentation and User Guide, (https://www.ni.com/docs/en-US/bundle/teststand/page/user-manual-welcome.html?srsltid=AfmBOorC7ZipP7a43wlhKex7mn682IlPTen6IcZuntAirubJwYsEa3e5)

9.2 Seminar / laboratory / project	Hours HEI	Hours CO	Teaching methods	Obs.
1. **Introduction to Electronic Testing & Instrumentation Basics** Safety, ESD handling, oscilloscope/multimeter	2			

familiarization, signal acquisition, measurement fundamentals.				
2. **Digital & Mixed-Signal Testing** Logic analyzers, protocol analyzers (I2C/SPI/UART), timing analysis, noise and signal integrity tests.	2			
3. **Automated Test Equipment (ATE) & LabVIEW Fundamentals** PXI system configuration, synchronization, virtual instrument (VI) creation, automated sequences and data logging.	2			
4. **DUT Specifications, Test Requirements & Test Plan Development** Reading datasheets, extracting test objectives, defining parametric vs. functional tests, building test documentation.	2			
5. **Interfacing with DUTs & Stimulus-Response Testing** Analog/digital stimulus generation, monitoring outputs, using fixtures and jigs, protection circuits, debugging.	2			
6. **Fault Injection, Robustness & Reliability Testing** Fault simulation (opens/shorts), environmental stress testing, robustness evaluation, MTBF and burn-in procedures.	2			
7. **System-Level Testing, Data Management & Final Project** SystemLink for connected testing, data analysis and automated reporting with DIAdem/FlexLogger, final test procedure implementation & oral defense.	2			

Bibliography
1. National Instruments, *LabVIEW Core 1 (https://learn.ni.com/learning-paths/labview-core-1)*
2. National Instruments, *LabVIEW Core 2 (https://learn.ni.com/learning-paths/labview-core-2-course)*
3. National Instruments, TestStand Documentation and User Guide, (https://www.ni.com/docs/en-US/bundle/teststand/page/user-manual-welcome.html?srsltid=AfmBOorC7ZipP7a43wlhKex7mn682llPTen6lcZuntAirubJwYsEa3e5)

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 course content aligns with the requirements of the international test and measurement community (IEEE, IPC, ISO) and with industrial expectations of companies working in electronics, embedded systems, automation, and manufacturing (NI, Emerson, Siemens, Continental, Bosch). The emphasis on ATE, automated testing workflows, data management, and DUT validation reflects current practices in R&D, production testing, and quality assurance. The strong practical component ensures graduates acquire the competencies sought in system testing, reliability engineering, product validation, and industrial automation labs.

11. Evaluation

Activity Type	Evaluation criteria	Evaluation methods	Weight in final grade
11.1 Lecture	Conceptual understanding and design formulation	Written exam	50%
11.2 Seminar/ Laboratory/Project	Practical implementation, reporting	Continuous in-lab evaluation + final report	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: 15.09.2025	Lecturers		Signature
	Course	*Prof.dr.ing. Horia Hedesiu*	
	Applications		

Date of approval by the Department of Automation Council 24.11.2025	Director of the Department of Automation Prof.dr.ing. Honoriu VĂLEAN
Date of approval by the Faculty of Automation and Computer Science Council 28.11.2025	Dean Prof.dr.ing. Vlad MUREȘAN