SYLLABUS

1. Data about the program of study

1.1 Institution	Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Electronics, Telecommunications and information Technology
1.3 Department	Applied Electronics
1.4 Field of study	Electronic Engineering, Telecommunications and Information Technologies
1.5 Cycle of study	Bachelor of Science
1.6 Program of study / Qualification	Applied Electronics / Engineer
1.7 Form of education	Full time
1.8 Subject code	48.00

2. Data about the subject

2.1 Subject name	**Virtual Instrumentation**						
2.2 Subject area	Supervisory Control and Data Acquisition						
2.3 Course responsible	Assoc. Prof. Gabriel CHINDRIS, PhD. Eng. – gabriel.chindris@ael.utcluj.ro						
2.4 Teacher in charge with seminar / laboratory / project	Assist. Prof. Ionel BACIU, PhD Eng. – ionel.baciu@ael.utcluj.ro						
2.5 Year of study	IV	2.6 Semester	1	2.7 Assessment	V	2.8 Subject category	DS/DI

3. Estimated total time

3.1 Number of hours per week	4	of which: 3.2 course	2	3.3 seminar / laboratory	2
3.4 To Total hours in the curriculum	56	of which: 3.5 course	28	3.6 seminar / laboratory	28

Distribution of time	hours
Manual, lecture material and notes, bibliography	14
Supplementary study in the library, online specialized platforms and in the field	10
Preparation for seminars / laboratories, homework, reports, portfolios and essays	14
Tutoring	3
Exams and tests	3
Other activities:	0

3.7 Total hours of individual study	44
3.8 Total hours per semester	100
3.9 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 curriculum	Passive and active electronic devices; Analog and Digital electronics fundamentals.
4.2 competence	Fundamentals of data acquisition systems, A/D and D/A conversion systems, microcontroller/microprocessor systems and programming fundamentals, graphical representation of data, beginner skills in using computers and peripherals.

5. Requirements (where appropriate)

5.1. for the course	Amphitheatre, TUCN
5.2. for the seminars / laboratories / projects	Laboratory, TUCN

6. Specific competences

Professional competences	C2. To apply basic methods for signal acquisition and processing • C2.1 Temporal, spectral and statistical characterization of signals • C2.2 Explaining and interpreting the methods of acquisition and processing of signals • C2.3 Use of simulation environments for signal analysis and processing • C2.4 Use of the specific method and tools for signal analysis C3. To apply knowledge, concepts and basic methods regarding computing systems' architecture, microprocessors, microcontrollers, programming languages and techniques • C3.3 Solving concrete practical problems including elements of data structures and algorithms, programming and use of microprocessors or microcontrollers • C3.4 Development of programs for a general and / or specific programming language, starting from the specification of the requirements and until the execution, debugging and interpretation of the results in correlation with the processor used • C3.5 Projects involving hardware (processors) and software (programming) components
Cross competences	N.A.

7. Discipline objectives (as results from the key competences gained)

7.1 General objective	Developing competences in Virtual Instrumentation.
7.2 Specific objectives	1. Recognizing and understanding basic concepts specific to SCADA. 2. Developing skills and abilities necessary for the use of SCADA. 3. Developing skills and abilities for acquire, analyze and present experimental data.

8. Contents

8.1 Lecture (syllabus)	Teaching methods	Notes
1. Course description. SCADA and Virtual Instrumentation.	Presentation, heuristic conversation, exemplification,	Use of .ppt presentation, projector, whiteboard.
2. Open loop control systems, closed loop control systems.		
3. P-PI-PID control systems.		
4. SCADA: architectures.		
5. Industrial sensors and transducers for temperature.		

6. Signal conditioning for temperature measurements: evaluation of performance and error.	problem presentation, teaching exercise, case study, formative evaluation.	
7. Actuators and DC/AC motors control.		
8. Advanced A/D techniques: dithering and interpolation. Sources of error in A/D systems.		
9. Embedded SCADA architectures.		
10. Real-time programming techniques for SCADA.		
11. Network distributed computing for industrial control.		
12. SCADA software design. Safety in SCADA.		
13. SCADA applications review.		
14. Recapitulation. Preparation for the final exam.		

Bibliography
1.Gabriel Chindris, Horia Hedesiu – *Proiectarea grafica a sistemelor de control pentru aplicatii industriale*, Ed. Mediamira, ISBN 978-973-713-242-0, Cluj-Napoca, 2009;
2.George C. Barney – Intelligent Instrumentation – ISBN 0-13-468216 (2001)
3. Richard C. Dorf – Modern Control Systems - ISBN 0-13-145733-0 (2005)

8.2 Seminar / laboratory / project	Teaching methods	Notes
1. Introduction. Safety measures in SCADA lab.	Didactic and experimental proof, didactic exercise, teamwork	Use of laboratory instrumentation, experimental boards, computers, white/magnetic board
2. LabVIEW intro.		
3. LabVIEW loops.		
4. LabVIEW data types.		
5. I/O and files in LabVIEW.		
6. Data acquisition in LabVIEW.		
7. Half semester laboratory test. (test T1)		
8. Acquire, analyze and present: LabVIEW.		
9. Matlab/Simulink interfaces.		
10. Real-time and network distributed programming.		
11. Industrial networks and LabVIEW.		
12. UI & UX design.		
13. End of semester laboratory test. (test T2)		
14. Laboratory work recovery and finalization of activity		

Bibliography
1.Ionel Horea Baciu, Alexandra Fodor – Instrumentatie Virtuala – support teoretic pentru lucrările de laborator
2. Mahesh L. Chugani – LabVIEW Signal Processing - ISBN 0-13-972449-4 (2001)
3. National Instruments Corp – LabVIEW Core 1 Course Manual, Part Number 325290A-01, October 2009 Edition
4. National Instruments Corp – LabVIEW Core 2 Course Manual, Part Number 325292A-01, October 2009 Edition

9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

The discipline content and the acquired skills are in agreement with the expectations of the professional organizations and the employers in the field, where the students carry out the internship stages and/or occupy a job in the field of industrial process control and monitoring and the expectations of the national organization for quality assurance (ARACIS).
As a result of bridging course content with professional associations and employers in the field, National Instruments Inc. is granting for each student a free one year SW license is provided (NI LabVIEW, 1000

EUR/user) and a free CLAD exam presentation (Certified LabVIEW Application Developer – NI professionals: 500 EUR/student).

10. Evaluation

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade
10.4 Course	The level of acquired theoretical knowledge and practical skills	Summative evaluation written exam (E)	40%
10.5 Seminar/ Laboratory	The level of acquired knowledge and abilities	- Continuous formative Evaluation and practical lab tests T1 and T2;	60%
10.6 Minimum standard of performance			

Quality level:

Minimum knowledge:

- ✓ Knowledge of open/closed loop control systems
- ✓ Knowledge of P-PI-PID control systems
- ✓ Knowledge of signal conditioning and biasing of industrial sensors/transducers
- ✓ Knowledge of LADDER diagrams, state-machine diagrams
- ✓ Knowledge of fundamentals of designing SCADA microsystems, implementing safety procedures in industrial control

Minimum competences:

- ✓ To be able to design a closed loop control system
- ✓ Design a biasing/signal conditioning circuitry for thermocouples, thermistors, RTD and IC Sensors
- ✓ Design a closed loop control system for DC, BLDC and AC-servo motors
- ✓ U se the lab instrumentation (data acquisition systems, real-time systems, cRIO, PXI and
- ✓ LabVIEW);

Quantitative level:

- T1, T2 ≥ 5 and E ≥ 5 and 0,4E+0,3T1+0,3T2 ≥ 4.5
- The minimum standard performance should cover basic knowledge in SCADA and instrumentation and beginner level of proficiency for a LabVIEW user.
- Written exam topics are scaled as follows:
  - 1 topic for minimal standard performance;
  - 1 topic with medium difficulty level;
  - 1 advance topic;
- The practical laboratory work and tests are scaled as follows:
  - Minimal standard performance is acquired by attending and completing ALL lab activities and passing T1;
  - T2 is aimed for medium and advanced users. Still, it can be passed with minimal knowledges acquired in previous steps.

Date of filling in:	Responsible	Title Surname NAME	Signature
21.06.2024	Course	Assoc. Prof. Gabriel CHINDRIS, PhD Eng.	
		Assist. Prof. Ionel BACIU, PhD Eng.	

Date of approval in the Department of Applied Electronics 28.06.2024	Head of Department Prof. Dorin PETREUS, PhD Eng.
Date of approval in the Council of Faculty of Electronics, Telecommunications and Information Technology 11.07.2024	Dean Prof. Ovidiu Aurel POP, PhD Eng.