9. Industrial process measurements

GENERAL INFORMATION ABOUT THE COURSE		
Course coordinator	Tomislav Veliki, PhD, assistant professor	
Course name	**Industrial process measurements**	
Study program	**Mechanical engineering**	
Course status	Elective	
Year	2	
Semester	3	
Number of credits and teaching methods	ECTS student load coefficient	4
	Number of hours (lectures + seminars + exercises)	15+0+30

1. DESCRIPTION OF THE COURSE

1.1. Course objectives

Train students to undertake research and autonomously use components in measuring systems which include the measuring of thermal and process values. The course enables students to understand and apply important components of scientific and research work, such as: measuring instruments, standard systems, traceability transmission and measurement uncertainty estimations, as well as assembling measurement systems with the required accuracy for measuring temperature, pressure, humidity, flow, mass and volume.

1.2. Course enrolment prerequisites *(if applicable)*

1.3. Expected course learning outcomes

1. Understand the fundamental methods of measuring, types, classification and fundamental properties of measuring instruments for measuring process values.
2. Use measuring concepts: reference points, traceability and calibration of measuring instruments, accuracy, precision, hysteresis effects, error propagation and stability of measuring instruments.

3. Knowing how to identify determinants of the measuring pyramid: international and national standards, authorisation, test and measuring laboratories, respective systems.
4. Define components of metering systems: acquisition, conversion, registration and processing of process measuring signals. Metering information system.
5. Interpret measurement results, calculate determinants of metering certainty, assess ability of system integrating measurement instruments.
6. Autonomously evaluate metering equipment, autonomously conduct measurements, achieve a measuring system for sought metering uncertainties in a given context and define mechanisms for ensuring measurement traceability.

1.4. Course content

1. Introduction. Metrological infrastructure
2. Metrology
3. Signal chain
4. Measuring temperature: international temperature scale ITS-90
5. Measuring temperature: Resistance thermometers
6. Measuring temperature: Thermocouples
7. Radiation thermometer: Liquid thermometers
8. Measuring pressure
9. Measuring pressure: Applications
10. Measuring flow and flow rate
11. Measuring humidity
12. Measuring thermal energy
13. Measuring levels, Measuring weight
14. Measurement certainty
15. Assembling signal chains

1.5. Types of teaching	☒ Lectures ☒ Seminars and workshops ☒ Exercises ☐ Distance learning ☐ Field work	☒ Autonomous exercises ☐ Multimedia and network ☒ Laboratory ☒ Mentor assistance ☐ Other types
1.6. Comments		

1.7. Student obligations *(attendance at classes, lectures, tutorials, seminars)*

1.8. Tracking student work (proportion of individual activities in terms of ECTS credits based on the total number of ECTS credits)

Class attendance	1.5	Class participation		Seminar paper		Experimental work	1
Written exam		Oral exam	1	Essay		Research	0.5
Project		Continual assessment of knowledge		Written seminar paper		Practical work	
Online activity							

1.9. Grading and assessment of student work during the semester and for the final exam *(interim exam, written exam, oral exam)*

Attendance at lectures and exercises
Solving interim exams
Passing the oral and written exam

1.10. **Mandatory literature** (relevant at the time of submitting the proposed study program)

- James W. Dally, William F. Riley, Kenneth G. McConnell, Instrumentation for Engineering Measurements, 1993. JOHN WILEY & SONS, INC.

1.11. Supplementary literature (relevant at the time of submitting the proposed study program

- Ivan Piljac, Senzori fizikalnih veličina i elektroanalitičke metode, MEDIAPRINT, 2010.
- Richard S. Figliola, Donald E. Beasley; Theory and Design for Mechanical Measurements, 6th Edition, 2015., JOHN WILEY & SONS, INC
- Biserka Runje; MJERITELJSTVO, FSB – Katedra za mjerenje i kontrolu, Predavanja iz kolegija MJERITELJSTVO, Zagreb, 2013.

1.12. Manner of tracking quality to ensure the acquisition of exit knowledge, skills and competences

2. COMBINING THE LEARNING OUTCOMES, TEACHING METHODS AND ASSESSMENT OF THE LEARNING OUTCOMES

2.1. Class participation	*2.2. Student participation*	*2.3. Learning outcome*	*2.4. Assessment method*
Lectures	Actively follow lectures, participation in classes	1 - 6	Written exam and oral exam (80%)
Exercises	Activities in teaching and attending exercises	1 – 6	Written exam and oral exam (80%)