Course: Process Measurement and Control		
Language: English		
Lecturer: **Prof. Nenad Bolf, Ph. D.**		
TEACHING	**WEEKLY**	**SEMESTER**
Lectures	**3**	**45**
Laboratory	**2**	**30**
Seminar	**1**	**15**
		Overall: 90
		ECTS: 7

E-LEARNING:

Electronic educational materials and distance learning will be available using Moodle programming tool. The teaching process will be combined partially via Internet wherein the teacher will take over the role of mentor, partly in the classroom. Remote control application for distance processes approach will be demonstrate during laboratory work.

PURPOSE:

To teach students modern methods of process control, measurements and diagnostics, metrology and metrological infrastructure.

THE CONTENTS OF THE COURSE:

System and system approach. Fundamentals of control theory. Basic control principles. Manual and automatic control, feedback and feedfoward control.

Functional structure of a control loop: process – measuring sensor/transducer – controller – actuator.

Process dynamics. Mathematical modelling of process and control loop. First and second order systems. Higher order systems. Time constant. Dead time.

Measuring and testing; conception, principles and theoretical foundations. Measuring sensor, transducer and instruments characteristics.

Calibration and traceability, measuring error and uncertainty. Reliability, repeatability and reproducibility of measurements.

Legal metrology. Organisation of metrological services, accreditation, certification. Measuring and testing laboratories. Instruments' maintenance and calibration. Quality assurance in measurement and testing. Standards and referent materials.

Measurement, sensors and transducers of temperature, pressure, flow, level, concentration, force. Basics of analytical measurements. Measurement of properties: mechanical, thermal, electrical, optical. Humidity and moisture.

Intelligent measuring transducers and instruments. Software sensors.

Controllers. On-off control. Proportional, integral and derivative control. PID controller.

Tuning concept. Tuning control systems. Closed-loop tuning methods. Open loop tuning methods. Integral methods. Adaptive tuning. Stability.

Cascade control. The concept of cascade control. Simple applications. Complex examples. Guiding principles for implementing cascade control.

Feedforward control. Steady-state and dynamic feedforward control. Combined feedforward and feedback control. Multivariable control problem. Implementing multivariable control.

Control valves. Types of control valves. Actuators and positioners. Control valve characteristics. Control valve selection and sizing. Control valve dynamic performance.

Special-purpose concepts. Computing components. Ratio control. Override control. Selective control. Split-range control.

Process nonlinearities. Nonlinearity compensation. Adaptive control.

Modern control system architecture. System components. Supervisory control systems. Distributed control systems (DCS). Sequential and batch control.

Process control and process management. Statistical process control. Statistical quality control. Artificial intelligence and expert systems. Fuzzy and neural network-based control. Basics of machine learning.

GENERAL AND SPECIFIC COMPETENCE:

Acquiring knowledge on modern methods of process measurement and control, control systems, diagnostics, modelling and computer simulations. Using of process measurement and control equipment.

KNOWLEDGE TESTING AND EVALUATION:

Written and oral exams.

MONITORING OF THE COURSE QUALITY AND SUCCESSFULNESS:

Student's survey

LITERATURE:

Course material, presentations and simulations on the course web page.

Marlin, T. E., *Process Control, Design Processes and Control System for Dynamic Performance*, McGraw-Hill, 2005

Seborg, D. E., Edgar, T. F., Mellichamp, D. A., *Process Dynamics and Control*, Wiley International, 2004

Smith, C.L. *Advanced Process Control*, Wiley-AIChE, 2010

MATLAB, The *Language of Technical Computing*, The MathWorks, Inc., 2012.