Name of the subject: ***Instrumentation-automation 2.***	***NEPTUN-code:*** KMXMA6ABNE	***Contact hours/week:*** 2 lectures + 0 practice + 2 lab. practice
Credits: 4 **Requirement**: exam	***Prerequisite:***	
Lecturer: Árpád Varga	***Assignment:***	***Faculty and institute:*** Kandó Kálmán Faculty of Electricity Institute of Instrumentation and Automation

Thematics:	**Week**	**Hours**
Aims, tasks, methods and devices of measurement of non-electric quantities in general. Proper conditions of measurement execution. Transducer types and overall characteristics. Construction and connection modes of sensors and transducers, standardized output signal levels. Overview of methods and instruments for measurement data acquisition and storage. Precision of measurement devices and measurement errors, Ingress Protection (IP) marking. Static and dynamic characteristics and calibration of measurement devices.	**1.**	**2**
Measuring spatial distance: continuous distance vs. level measurements. Proximity, reference and limit switches: mechanical, inductive and capacitive types. Relative and absolute encoders for measuring distance and rotation angle. Ultrasonic and optical distance sensors, light barriers. Measurement of liquid and pellet level in reservoirs: mechanical, ultrasonic and resistive solutions.	**2.**	**2**
Concept of force and torque measurement. Reduction of force/torque measurement to mechanical deformation: strain gauges, optical displacement methods, piezo-principle. Construction of compact force/torque measurement cells, multi axis force and torque measurement devices. Reduction of force/torque measurement to magnetic properties, magneto-elastic cells.	**3.**	**2**
Measurement of angular velocity. Stroboscopes, DC/AC tachogenerators, optical, magnetic tachometers. Application example: Antilock Braking System (ABS) sensors, used in automotive industry. Vibration measurements. Role of vibration measurement and analysis in failure diagnostics. Accelerometers: piezoelectric, electromagnetic types. Dynamic characteristics of accelerometers. Optical vibration measurement methods.	**4.**	**2**
Basics of heat propagation in solids, liquids and gases (conductivity, convectivity, radiation). Temperature measurement devices: resistance thermometer, thermistors, thermocouples, thermal cameras. Construction of thermic transducers, calibration.	**5.**	**2**
Temperature measurements in liquids, gases and on solid surfaces. Main optical quantities (wavelength, intensity), spectral properties. Light sensors: photocells, photoresistors, phototransistors, photodiodes, color sensors. Role of “smart” cameras in production quality control.	**6.**	**2**
Theoretical test 1.	**7.**	**2**
Concept of measurement of absolute and differential pressure. Mechanical construction of pressure transducers, conversion possibilities of pressure to electric signal (deformation, resistive, capacitive, piezo-principles).	**8.**	**2**
Basic quantities of flow measurement: static/dynamic pressure, local speed, volume and mass flow rate. Local speed measurement: Pitot-static tube. Volume-flow rate measurement: Venturi-tube, orifice flow meters. Proper configuration of measurement sections, concept of mechanical losses in fluids, possible compensation methods.	**9.**	**2**
Special volume and mass flow rate measurement devices: turbine flow meters,	**10.**	**2**

magneto-hydrodynamic (MHD), ultrasonic flow meters. Concept of Coriolis-principle, operation of Coriolis flow-meters. Flow-meters based on thermal conductivity. Comparison of different flow meters from viewpoint of usability.		
Modern MEMS (Micro Electro Mechanical) sensors: angular orientation sensing (gyro sensors), multi-axis acceleration measurement used in “smart” consumer electronic devices. Several industrial method and device for orientation and acceleration measurement.	**11**	**2**
Theoretical test 2.	**12**	**2**
Theoretical test retakes	**13**	**2**
Exam consultation.	**14**	**2**

Lab. practice thematics:	**Week**	**Hours**
Familiarization with Siemens S7-1200 PLCs and the TIA prtal development environment, creating PLC project and tag table.	**1.**	2
Solving simple programming problems using ladder logic, Set-Reset coils, impulse detection.	**2.**	2
Introduction to timers and counters, comparators.	**3.**	2
Solving programming problems using functions and function blocks.	**4.**	2
Small PLC programming project: traffic light control, part 1: infinite operation.	**5.**	2
Small PLC programming project: traffic light control, part 2: night and day operation mode, starting, stopping conditions.	**6.**	2
Laboatory test 1. Programming the control of simple repetitive processes (e.g. industrial mixer, traffic lights). By the end of the lab session, students must have a working PLC program to complete the test!	**7.**	2
Configuring HMI, setting up HMI graphic elements.	**8.**	2
Reading analogue values, trend view display settings.	**9.**	2
Handling data blocks containing one-dimensional arrays with PLC.	**10.**	2
Array handling mini project part 1: programming FILO storage.	**11.**	2
Array handling mini project part 2: programming a small statistic evaluation application (finding the minimal, maximal elements in an array, array avergae).	**12.**	2
Laboratory test 2.: Programming of tasks requiring the handling of arrays by means of PLC and HMI (e.g. calculation of moving averages, creation of FILO memory, automatic loading of arrays, etc.)	**13.**	2
Lab test retakes.	**14.**	2

Requirements:

The subject is graded by an exam mark.

In order to obtain the exam signature from the subject, the two theoretical and two laboratory tests must be passed with at least a satisfactory mark 2. During the semester, 1 theoretical and 1 laboratory test can be retaken.

The grade calculated from the average of the two laboratory test marks is the laboratory grade, and the grade calculated from the average of the two theoretical test marks is the theoretical grade.

The grade for the semester is the average of the theoretical and laboratory grades (rounded to the nearest tenth). If the semester grade is greater than or equal to 3.5, the student may accept the offered exam mark of 4. If the semester grade is greater than or equal to 4.5, the student may accept the offered exam grade of 5. If the semester grade is less than 3.5 or the student does not accept the offered exam mark, the student must take an exam in the examination period, containing an oral and a written part. In this case, the final mark is calculated as the average of the laboratory, theoretical and exam marks.

Literature: