<table>
<tr><td colspan="2">NAME OF THE COURSE</td><td colspan="5">Physical Principles of Sensors</td></tr>
<tr><td>Code</td><td>PMP20G</td><td>Year of study</td><td colspan="4">1st and 2nd year of graduate study</td></tr>
<tr><td>Course teacher</td><td>doc. dr. sc. Marin Kosović</td><td>Credits (ECTS)</td><td colspan="4">5</td></tr>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2"></td><td rowspan="2">Type of instruction (number of hours)</td><td>L</td><td>S</td><td>E</td><td>F</td></tr>
<tr><td>30</td><td>15</td><td>15</td><td></td></tr>
<tr><td>Status of the course</td><td>Elective</td><td>Percentage of application of e-learning</td><td colspan="4">30%</td></tr>
<tr><td colspan="7">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="6">Understanding the physical principles of sensors. Practical work using the Arduino / Raspberry Pi microcontrollers.</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="6">Programming and general physics knowledge</td></tr>
<tr><td>Learning outcomes expected at the level of the course (4 to 10 learning outcomes)</td><td colspan="6">Upon passing the course on Physical principles of sensors, the student will be able to:
• Understand the basic sensor’s characteristics
• Describe mathematical models of sensors
• Explain the physical principles underlying sensor operation
• Describe the materials and methods used to make the sensor
• Describe the types of sensors and their application
• Understand the basics of programming the Arduino / Raspberry Pi microcontroller
• Create a sensory device based on Arduino / Raspberry Pi technology</td></tr>
<tr><td>Course content broken down in detail by weekly class schedule (syllabus)</td><td colspan="6">Lectures:
• Introduction and Sensor characteristics (6 Hours)
  • Sensors, Signals, Systems, Sensor Classification, Mathematical Models, sensor electronics, Sensor Features: Accuracy, Precision, Sensitivity, Selection, Minimum Detection, Linearity, Hysteresis
• Physical principles of sensors (8 hours)
  • Hall effect, Seebeck effect, Peltier effect, Doppler effect, Kerro effect, photoelectric effect, piezoelectric effect, pyroelectric effect, photoluminescence effect, dielectric effect and other physical principles
• Materials and Methods of Sensor Design (4 hours)
  • Materials, Nanomaterials, Surface Methods, MEMS Methods
• Sensor types (6 hours)
  • pressure sensors, temperature sensors, flow sensors, moisture sensors, speed sensors, force sensors, acceleration sensors, ultrasonic detectors, light detectors, ionizing radiation detectors
• Arduino / Raspberry Pi technology (6 hours)
  • Programming, automation and electronics of Arduino / Raspberry Pi microcontroller, sensor protocols, commercially available sensors

Practical exercises
• During the semester students work on a project based on the development of a sensory device with Arduino / Raspberry Pi technology (15 hours).

Seminar
• At the end of the project students will be presenting a seminar related to the project (15 hours).</td></tr>
<tr><td>Format of instruction</td><td colspan="3">lectures
practical exercises
seminars</td><td colspan="3"></td></tr>
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Student responsibilities	Attendance and commitment of students to lectures, practical work and seminars.					
Screening student work *(name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)*	Class attendance	1	Research		Practical training	
	Experimental work	1.5	Report		(Other)	
	Essay		Seminar essay	0.5	(Other)	
	Tests		Oral exam	2	(Other)	
	Written exam		Project		(Other)	
Grading and evaluating student work in class and at the final exam	The final grade of the course will consist of three parts: 1) Evaluation of practical work (35%) 2) Evaluations of seminar presentations (15%) 3) Evaluation of theoretical knowledge (50%). The evaluation of the practical work is obtained upon completion of the project and seminar. During the semester theoretical knowledge is evaluated through the tests or by an oral exam at the end of the semester.					

Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	J.Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications" 5th edition, Springer, 2016.	2	internet
	T. Karvinen, K.Karvinen, V. Valtokari, Make: Sensors: A Hands-On Primer for Monitoring the Real World with Arduino and Raspberry Pi , Maker Media, 2014.	2	internet

Optional literature (at the time of submission of study programme proposal)	• Kourosh Kalantar-zadeh, Sensors: An Introductory Course, Springer, 2013. • K.Karvinen, T. Karvinen, Make: Getting Started with Sensors, Maker Media, 2014.
Quality assurance methods that ensure the acquisition of exit competences	Statistics of the exam results and student evaluation via an anonymous survey conducted by the University of Split.
Other (as the proposer wishes to add)	