

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Senzorji v procesnem vodenju
Course title:	Sensors in Process Control

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Senzorske tehnologije, 3. stopnja	/	1	1
Sensor Technologies, 3 rd cycle	/	1	1

Vrsta predmeta / Course type Izbirni / Elective

Univerzitetna koda predmeta / University course code: ST3-550

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
15	15			15	105	5

**Navedena porazdelitev ur velja, če je vpisanih vsaj 15 študentov. Drugače se obseg izvedbe kontaktnih ur sorazmerno zmanjša in prenese v samostojno delo. / This distribution of hours is valid if at least 15 students are enrolled. Otherwise the contact hours are linearly reduced and transferred to individual work.*

Nosilec predmeta / Lecturer: Prof. dr. Juš Kocijan

Jeziki /	Predavanja / Lectures:	Slovenski ali angleški / Slovene or English
Languages:	Vaje / Tutorial:	Slovenski ali angleški / Slovene or English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Zaključen študij druge stopnje ustrezne (naravoslovne ali tehniške) smeri ali zaključen študij drugih smeri z dokazanim poznavanjem osnov področja predmeta (pisna dokazila, pogovor).

Prerequisites:

Completed second cycle studies in natural sciences or engineering or completed second cycle studies in other fields with proven knowledge of fundamentals in the field of this course (certificates, interview).

Vsebina:

Uvodna poglavja

- Najpomembnejši elementi sistemov procesnega vodenja.
- Senzorji in merilni pretvorniki.
- Aktuatorji in izvršni členi.
- Regulatorji, krmilniki in procesni računalniški sistemi.
- Signalne povezave med elementi sistemov za vodenje.

Stopenjski bližinski senzorji

- Lastnosti posameznih vrst bližinskih senzorjev:
 - induktivni senzorji,
 - kapacitivni senzorji,

Content (Syllabus outline):

Introduction

- Most important process-control elements
- Sensors and transducers.
- Actuators and final elements.
- Controllers, PLCs and process computer systems.
- Communication links between control- system elements.

Proximity sensors

- Properties of types of proximity sensors:
 - inductive sensors,
 - capacitive sensors,
 - optical sensors,
 - magnetic sensors,

<ul style="list-style-type: none"> ○ optični senzorji, ○ magnetni senzorji, ○ ultrazvočni senzorji, ○ pnevmatični senzorji. • Na kaj moramo paziti pri izbiri bližinskih senzorjev? • Navodila za uporabo bližinskih tipal. <p>Merjenje temperature v procesni industriji</p> <ul style="list-style-type: none"> • Pogosto uporabljeni senzorji za temperaturo. • Nekateri problemi pri merjenju temperature s Pt uporovnimi senzorji. • Nekateri problemi pri merjenju temperature s termočleni. • Navodila za uporabo senzorjev temperature. <p>Merjenje tlaka v procesni industriji</p> <ul style="list-style-type: none"> • Nekateri problemi pri merjenju tlaka v industrijskem okolju. • Navodila za uporabo senzorjev tlaka. <p>Merjenje pretoka v procesni industriji</p> <ul style="list-style-type: none"> • Splošno o merjenju pretokov. • Merilniki pretoka na osnovi diferencialnega tlaka. • Elektromagnetni induktivni merilnik pretoka. • Vrtinčni merilnik pretoka. • Coriolisov merilnik pretoka. • Termični-masni merilnik pretoka. • Navodila za uporabo merilnikov pretoka. <p>Signali in prenos podatkov v sistemih vodenja industrijskih procesov</p> <ul style="list-style-type: none"> • Dvožična vezava merilnih pretvornikov. • Nekateri primeri vstopa motenj v signalne povezave. • Digitalne vezave merilnih pretvornikov. 	<ul style="list-style-type: none"> ○ ultrasonic sensors, ○ pneumatic sensors. • Important issues for proximity sensors selection. • Instructions for practical use of proximity sensors. <p>Temperature measurement in process industry</p> <ul style="list-style-type: none"> • Frequently used temperature sensors. • Problems in temperature measurements with Pt resistance sensors. • Some problems in using thermocouples. • Instructions for practical use of temperature sensors. <p>Pressure measurement in process industry</p> <ul style="list-style-type: none"> • Some problems in pressure measurement in industrial environments. • Instructions for practical use of pressure sensors. <p>Flow measurement in process industry</p> <ul style="list-style-type: none"> • General introduction in flow measurement. • Differential-pressure based flowmeters. • Electromagnetic inductive flowmeter. • Vortex flowmeter. • Coriolis flowmeter. • Termical-mass flowmeters. • Instructions for practical use of flowmeters. <p>Signals and data transmission in industrial process control systems</p> <ul style="list-style-type: none"> • Two-line connection of measurement transducers. • Some examples of disturbances in signal connections. • Digital communications between measurement transducers.
--	---

Temeljni literatura in viri / Readings:

Knjige / Books:

- Belič. Gradniki in tehnologije v sistemih vodenja. Založba FE in FRI, Ljubljana, 2012.
- J. Petrovčič, J. Kocijan. Uporaba gradnikov v sistemih vodenja. Založba FE in FRI, Ljubljana, 2002.
- W. de Silva. Sensors and actuators: control system instrumentation. CRC Press, Boca Raton, Florida, 2007.

Revije / Periodicals:

- Sensors, MDPI, ISSN 1424-8220.

- IEEE Sensors Journal, IEEE, ISSN: 1530-437X.
- IEEE Control Systems, IEEE, ISSN: 1066-033X.

Cilji in kompetence:

Cilji predmeta so:

- razumevanje teoretičnih osnov senzorjev v procesnem vodenju,
- poznavanje praktičnih problemov pri uporabi industrijskih senzorjev,
- usposobljenost za načrtovanje senzorskih sistemov,
- usposobljenost za vrednotenje obstoječih senzorskih sistemov,
- usposobljenost slušateljev za kompetentne sogovornike z načrtovalcem sistemov vodenja.

Pridobljene kompetence:

- poznavanje osnovnih konceptov merjenja v procesnem vodenju,
- poznavanje najbolj pogostih vrst industrijskih merilnih sistemov,
- sposobnost primerjalne analize za izbiro in uporabo najpogostejših vrst senzorjev v procesnem vodenju,
- sposobnost primerjalne analize za izbiro signalov in vrst prenosa podatkov v sistemih procesnega vodenja.

Objectives and competences:

Course objectives:

- understanding theoretical principles of sensors in process control,
- knowing of the issues in industrial sensors' implementation,
- ability for sensor-systems design,
- ability to evaluate various sensor systems,
- training of competent professionals that are able to communicate with control-systems design engineers.

Competences:

- knowledge of basic concepts of process-control measurements,
- knowledge of the most frequent industrial measurements systems,
- ability for comparative analysis for selection and proper implementation of the most frequent sensors in process control,
- ability for comparative analysis of used signals and types of data transmission in process-control systems.

Predvideni študijski rezultati:

Znanje in razumevanje:

- poznavanje osnovnih konceptov za najbolj pogosta merjenja v procesni industriji,
- znanje o najbolj pogosto uporabljenih merilnikih,
- sposobnost izbire in pravilnega postopka montaže merilnikov,
- poznavanje signalov in prenosa podatkov v modernih sistemih procesnega vodenja.

Intended learning outcomes:

Knowledge and understanding:

- knowledge of of fundamental concepts of process-control measurements,
- knowledge about the most frequent used sensors in process control,
- ability for their selection and proper use,
- knowledge of signals and data transmission in modern process-control systems.

Metode poučevanja in učenja:

Interaktivno delo s študentom v okviru predavanj in seminarske naloge z vključevanjem metod komparativne analize, sinteze in prepoznavanja struktur in vzorcev znanja ter usmerjanega reševanja realnih problemov.

Learning and teaching methods:

Interactive work with a student in the frame of lectures and seminar work, including methods of comparative analysis, synthesis and recognition of knowledge structures and patterns, and supervised solving of real problems.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Seminarska naloga s predstavitvijo in zagovorom rešitve izbranega primera iz študentovega raziskovalnega dela.	50 %	Seminar work with presentation and defence of the proposed solving of the selected problem from student's research work.
Pisni del izpita, s katerim se preverjajo teoretična in praktična znanja o senzorjih v procesnem vodenju.	50 %	Written exam, which assesses knowledge of the theory and the implementation of concepts of sensors in process control.

Reference nosilca / Lecturer's references:

<ul style="list-style-type: none"> • KOCIJAN, Juš, GRADIŠAR, Dejan, BOŽNAR, Marija, GRAŠIČ, Boštjan, MLAKAR, Primož. On-line algorithm for ground-level ozone prediction with a mobile station. <i>Atmospheric environment</i>, 2016, vol. 131, 326-333. • ALEKSOVSKI, Darko, KOCIJAN, Juš, DŽEROSKI, Sašo. Ensembles of fuzzy linear model trees for the identification of multi-output systems. <i>IEEE transactions on fuzzy systems</i>, 2016, vol. 24, no. 4, 916-929. • KOCIJAN, Juš, HVALA, Nadja. Sequencing batch-reactor control using Gaussian-process models. <i>Bioresource technology</i>, jun. 2013, vol. 137, 340-348. • JUŽNIČ-ZONTA, Živko, KOCIJAN, Juš, FLOTATS, Xavier, VREČKO, Darko. Multi-criteria analyses of wastewater treatment bio-processes under an uncertainty and a multiplicity of steady states. <i>Water research</i>, 2012, vol. 46, no. 18, 6121-6131.
--