UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	MERITVE IN OSNOVE REGULACIJE PROCESOV
Course Title:	MEASUREMENTS AND FUNDAMENTALS OF PROCESS CONTROL

Študijski program in stopnja Study Programme and Level	**Študijska smer Study Field**	**Letnik Academic Year**	**Semester Semester**
VSŠP Kemijska tehnologija, 1. stopnja	**/**	**3.**	**5.**
PSP Chemical Technology, 1st Cycle	**/**	**3rd**	**5th**

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code:

Predavanja Lectures	**Seminar Seminar**	**Vaje Tutorial**	**Klinične vaje Work**	**Druge oblike študija**	**Samost. delo Individual Work**	**ECTS**
30	**15**	**30 LV**	**/**	**/**	**75**	**5**

Nosilec predmeta / Lecturer: prof. dr. Andrej Jamnik / Dr. Andrej Jamnik, Full Professor

Jeziki / Languages:

Predavanja / Lectures:	**slovenski / Slovenian**
Vaje / Tutorial:	**slovenski / Slovenian**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.	The course has to be assigned to the student.

Vsebina:	**Content (Syllabus outline):**
Merjenje procesnih spremenljivk Metrologija. Merski sistem. Enote in standardi. Hierarhija standardov. Sledljivost kalibracijske opreme do nacionalnih in mednarodnih standardov. Statične karakteristike merilnih instrumentov. Merjenje tlaka, nivoja, pretoka, temperature. Merjenje nekaterih ostalih količin. **Avtomatska regulacija procesov** Namen in pomen avtomatske regulacije kemijskih procesov. Osnovni pojmi in terminologija. Instrumentacijski in blokovni diagram, značilni elementi regulacijskega kroga. Odprti in zaprti regulacijski krog. Negativna povratna zanka. Standardni signali za prenos informacije v regulacijski zanki.	**Measurements of process variables** Metrology. Measurement system. Units and standards. Hierarchy of standards. Traceability of measurements. Static characteristics of measuring instruments. Pressure, level, flow, temperature measurements. Measurements of some other process variables. **Process control** Incentives for chemical process control. Basic concepts and terminology. Feedback loop. Open and closed control loop. Instrumentation and block diagrams. Standard signals for transmission of information in the control loop. Analog-to-digital and digital-to-analog signal conversion. **Dynamic characteristics of systems**

Analogno-digitalna in digitalno analogna pretvorba signalov. **Dinamične karakteristike sistemov** Časovni odzivi sistemov prvega in drugega reda na različne vhodne spremenljivke. **Izvršilni členi:** Avtomatski regulirni ventil. Regulirne črpalke. **Vrste povratnozančnih (feedback) regulatorjev** Dvopoložajna in tripoložajna regulacija. Proporcionalni, integrirni in diferencirni ter kombinirani načini regulacije. Avtomatska regulacija enostavnih procesov: regulacija temperature, nivoja in pH. **Laboratorijske vaje** Merjenje tlaka, pretoka, temperature in nekaterih drugih procesnih količin. Umerjanje instrumentov. Dinamične karakteristike sistemov 1., 2. in višjih redov. Laplaceova transformacija. Prenosne funkcije in njihova uporaba v regulacijski tehniki. Regulacija temperature, nivoja in pH. Karakteristike regulirnih ventilov. Dvopoložajna, P, PI in PID regulacija. Avtomatsko zajemanje podatkov.	Dynamic response of first and second-order measuring devices and processes on different input variables. **Final control elements**: pneumatic control valve and control pumps. **Types of feedback controllers** Two and three position controllers. Proportional, integral, derivative and other types of feedback controllers. Examples of simple control systems: control of temperature, level, and pH. **Laboratory practice** Measurement of pressure, flow, temperature and some other process variables. Calibration of some process measuring instruments. Dynamic characteristics of first, second and higher order systems. Laplace transforms. Transfer functions and the input-output models. Temperature, liquid level and pH control. Characteristics of control valves. Characteristics of the ON/OFF, P, PI and PID controllers. Automatic data acquisition.

Temeljna literatura in viri / Readings:

- P.W. Murrill, *Fundamentals of process control theory* (2. izdaja), Instrument Society of America (1993), 265 str., 40%.
- C.D. Johnson, *Process Control Instrumentation Technology* (5. izdaja), Prentice-Hall Inc. (1997), 638 str., 25%
- C. Pohar in sodelavci, *Praktikum iz meritev, regulacije in avtomatizacije*, interna skripta Katedre za fizikalno kemijo, Ljubljana (1994).

Dopolnilna literatura:
- R. Karba, *Gradniki sistemov vodenja* (1. izdaja), Ljubljana: Založba FER (1994). 326 str.
- G. Platt, *Process Control – A Primer for the Nonspecialist and the Newcomer* (2. izdaja), Instrument Society of America (1993), 207 str., 40%.

Cilji in kompetence:	**Objectives and Competences:**
Študenti spoznajo osnovne principe regulacijskega kroga s poudarkom na merjenju procesnih spremenljivk. Pridobijo temeljno znanje, ki je potrebno za nadaljnji samostojni študij na tem hitro razvijajočem se področju in za dialog s specialisti iz drugih strok.	The course informs the student with the basic principles of control loop with special emphasis on the measurement of process variables. It offers them the basic knowledge needed for further independent study in this rapidly developing field and make possible to dialogue with specialists from other disciplines.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Poznavanje različnih načinov merjenja procesnih spremnljivk. Razumevanje delovanja regulacijske zanke, osnov avtomatske regulacije, dinamičnih karakteristik regulacijskih sistemov in merilnih inštrumentov.	Knowledge and Comprehension Knowledge of different ways for measurements of various process variables. Understanding the operation of control loop, the basics of automatic control and dynamic characteristics of control systems and measuring instruments.
Uporaba Pridobljeno znanje je širše uporabno in ni omejeno zgolj na področje kemijske tehnologije.	Application Acquired knowledge is widely applicable and not limited only to the field of chemical technology.
Refleksija Na podlagi pridobljenega znanja o meritvah in regulaciji se bo študent sposoben bolje in hitreje vključiti v tehnološko-procesno delovno okolje.	Analysis On the basis of the knowledge about the measurements and process control, the student will be able to better and more quickly incorporate into the technological process working environment.
Prenosljive spretnosti Študent je sposoben povezati znanje iz več predmetov v celoto ter ga uporabiti pri svojem delu tako v teku študija kot tudi kasneje pri opravljanju svojega poklica.	Skill-transference Ability The students are able to complement knowledge from this course with those obtained in other subjects and use it in their work both in the course of the study as well as later in the professional career.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja, seminarji, laboratorijske vaje.	Lectures, seminars, laboratory practice.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni izpit po uspešno opravljenih laboratorijskih vajah. Ocenjevanje: 6-10 (pozitivno); 1-5 (negativno).	**100 %**	Written examination after successful completion of practical work. Marks: 6-10 (positive); 1-5 (negative).

Reference nosilca / Lecturer's references:

- **M. Tomšič**, J. Cerar, **A. Jamnik**, *Supramolecular structure vs. rheological properties : 1,4-butanediol at room and elevated temperatures*, Journal of colloid and interface science, 557, 2019, 328-335.

- **M. Tomšič, A. Jamnik,** G. Fritz, O. Glatter, L. Vlček, *Structural properties of pure simple alcohols from ethanol, propanol, butanol, pentanol, to hexanol : comparing Monte Carlo simulations with experimental SAXS data*, The journal of physical chemistry B, 111, 2007, 1738-1751.

- I. Dogša, **M. Tomšič**, J. Orehek, E. Benigar, **A. Jamnik**, D. Stopar, *Amorphous supramolecular structure of carboxymethyl cellulose in aqueous solution at different pH values as determined by rheology, small angle X-ray and light scattering*, Carbohydrate polymers, 111, 2014, 492-504.