

**UČNI NAČRT PREDMETA / COURSE SYLLABUS**

**Predmet:** TERMIČNA ANALIZA  
**Course Title:** THERMAL ANALYSIS

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
MAG Kemija, 2. stopnja	/	2.	4.
USP Chemistry, 2 <sup>nd</sup> Cycle	/	2 <sup>nd</sup>	4 <sup>th</sup>

**Vrsta predmeta / Course Type:**

izbirni strokovni / Elective Professional

**Univerzitetna koda predmeta / University Course Code:**

K2105

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
15	15	45 LV	/	/	75	5

**Nosilec predmeta /  
Lecturer:**

izr. prof. dr. Romana Cerc Korošec /  
Dr. Romana Cerc Korošec, Associate Professor

**Jeziki / Languages:**

**Predavanja / Lectures:** slovenski / Slovenian

**Vaje / Tutorial:** slovenski / Slovenian

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

Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.

**Prerequisites:**

The course has to be assigned to the student.

**Vsebina:**

1. Definicija pojma termična analiza. Termogravimetrija (TG), diferenčna termična analiza (DTA) in diferenčna dinamična kalorimetrija (DSC) – princip merjenja. Komplementarnost TG in DSC metode (termični razpad/fazni prehod).
2. Teoretske osnove termičnega razpada trdnih snovi; bazna linija pri TG in DSC krivulji.
3. Temperaturna kalibracija termoanalizatorja, kalibracija DSC instrumenta; fleksibilna kalibracija.
4. Analiza eksperimentalnih podatkov izmerjenih TG in DSC krivulj vzorcev z znano sestavo, primerjava z

**Content (Syllabus outline):**

1. Definition of the concept "thermal analysis". Thermogravimetry (TG); differential thermal analysis (DTA) and dynamic scanning calorimetry (DSC). TG and DSC as complementary methods (thermal decomposition/phase transition).
2. Thermal decomposition of solids (theoretical principles), baseline of TG and DSC curve.
3. Temperature calibration thermoanalyser, calibration of a DSC instrument, flexible calibration.
4. Analysis of experimental data from TG and DSC curves, obtained from the

objavljenimi TG krivuljami; kvalitativna in kvantitativna analiza preprostih in kompleksnejših zmesi.

5. Termična analiza polimernih materialov - steklast prehod, hladna kristalizacija, spremljanje polikondenzacije duroplastnih materialov z visokotlačno DSC, termična stabilnost polimerov.
6. Termična analiza tankih plasti – posebnosti in priprava vzorca za merjenje.
7. Termična analiza kot orodje za študij materialov in optimiranje njihove toplotne obdelave; analiza farmacevtskih substanc, eksplozivnih snovi, kompozitnih materialov; primeri optimiranja toplotne obdelave materialov.
8. Pulzna termična analiza .
9. Osnove termomehanske analize in dinamične mehanske analize.
10. Analiza sproščenih plinov s sklopitvijo termogravimetrija – masna spektrometrija in termogravimetrija-infrardeča spektroskopija.

Študentje se najprej seznanijo s teoretskimi osnovami termične analize in nato vsebino preverijo na eksperimentalnih vajah v obliki projektnega dela, ki se nanaša na vsebino študentove usmeritve.

compounds with a known composition; comparison with the published curves. Qualitative and quantitative analysis of simple and more complex mixtures.

5. Thermal analysis of polymeric materials (glass transition, cold crystallisation, following the condensation reaction of thermosets using high pressure DSC, thermal stability of polymers).
6. Thermal analysis of thin films – peculiarities and sample preparation.
7. Thermal analysis as a tool for studying materials and optimisation of their thermal treatment. Analysis of different types of materials including pharmaceutical substances, explosives and composites. Optimization of thermal treatment of materials (examples).
8. Pulse Thermal analysis.
9. Principles of thermomechanical and dynamic mechanical analysis.
10. Evolved gas analysis using coupled thermogravimetry-mass spectrometry and thermogravimetry-infrared spectroscopy techniques.

At the beginning of the course, the students are introduced to the theoretical principles of thermal analysis. These are then explored during experimental practice in the form of project work, which is related to the student's specialisation.

#### Temeljna literatura in viri / Readings:

- Handbook of Thermal Analysis and Calorimetry, Vol. 1 (Principles and Practice), M. E. Brown (urednik), Elsevier, Amsterdam 1998.
- Thermal methods; analytical chemistry by open learning, J. W. Dodd, K. H. Tonge, Chichester 1987.
- T. Leskelä: Thermoanalytical techniques in the study of inorganic materials, Dissertation, Helsinki 1996.

#### Cilji in kompetence:

#### Objectives and Competences:

*Cilji:* Spozna teoretske osnove termične analize in njeno uporabo na raznovrstnih področjih znanosti in tehnologije.

*Kompetence:* Obvlada principe v termične analize in jih zna uporabljati v praksi.

Objectives: Understanding of the basic theoretical principles of thermal analysis and the ability to use this method in different fields of science and technology.

Competences: Mastering the principles of thermal analysis and the ability to use them in practice.

### **Predvideni študijski rezultati:**

#### Znanje in razumevanje

Študent osvoji in zna uporabljati osnovne principe termične analize (izvesti meritev, prebrati in komentirati rezultat). S pomočjo literature se nauči termično analizo uporabiti za reševanje kompleksnih problemov.

#### Uporaba

Pridobljeno znanje zna povezati in uporabiti pri reševanju določenih problemov pri anorganskih in polimernih materialih ter farmacevtskih substancah, pri načrtovanju in optimiranju procesov v proizvodnji, ki so povezani s termično obdelavo in kontrolo kakovosti v industriji. Dobljene rezultate je sposoben kritično ovrednotiti.

#### Refleksija

Študent je sposoben uporabiti metode termične analize v praksi. Na osnovi pridobljenega znanja je sposoben kritično ovrednotiti izmerjene rezultate in jih primerjati z literaturnimi podatki.

#### Prenosljive spretnosti

Študent zna uporabljati literaturne podatke, načrtovati izvedbo meritev za reševanje določenega problema in povezovati teorijo s prakso. Kadar je potrebno, zna za reševanje problema v kombinaciji s termično analizo uporabiti dodatne metode npr. spektroskopske in rentgensko difrakcijo. Na ta način spozna povezanost različnih področij. Ustno in pisno zna poročati o rezultatih meritev, jih kritično analizirati, primerjati z literaturnimi podatki ter komentirati morebitna odstopanja.

### **Intended Learning Outcomes:**

#### Knowledge and Comprehension

Applying the acquired knowledge, the student can use basic principles of thermal analysis (performing measurement, interpret and comment a result). Thermal analysis can be used for solving more complex issues with the aid of references.

#### Application

Ability to merge the acquired knowledge and skills in order to solve certain issues in the field of inorganic and polymeric materials, pharmaceutical substances, for planning and optimising industrial processes connected with thermal treatment or quality control. Ability to critically evaluate the results obtained.

#### Analysis

Use the methods of thermal analysis in practice. On the basis of the knowledge acquired, the student is able to evaluate measured results and compare them with literature data.

#### Skill-transference Ability

Ability to use literature data, plan the execution of measurements to solve specific problems, and link theory with practice. Combining thermal methods with additional ones, i.e. spectroscopic and x-ray diffraction, when required. Thus, the student becomes acquainted with the interconnectedness of different fields.

The student can report on the results of measurements in oral and written form, critically analyse them, compare them with literature data and comment on possible deviations.

**Metode poučevanja in učenja:**

- Predavanje  
 - problemsko delo na seminarjih  
 - laboratorijske vaje: meritve  
 Priprava, izvedba in predstavitev projekta

**Learning and Teaching Methods:**

- Lectures  
 - Coursework during seminars  
 - Laboratory practice: measurements  
 - Project preparation and presentation

Delež (v %) /

Weight (in %) /

**Načini ocenjevanja:****Assessment:**

Ocena je sestavljena iz ocene pisnega izpita (50 %) in ocene kolokvija iz vaj (50 %); v primeru izvajanja projektnih nalog pa se bo 50 % delež ocene iz vaj razdelil na 20 % ocene projektnega dela in 30 % ocene iz kolokvija.

**50 %****50 %**

- written examination  
 - colloquium (20 % project work, 30 % colloquium)

**Reference nosilca / Lecturer's references:**

- R. Cerc Korošec, P. Bukovec, B. Pihlar, J. Padežnik Gomilšek: The role of thermal analysis in optimization of the electrochromic effect of nickel oxide thin films, prepared by the sol-gel method. Part 1. - *Thermochim. acta*. **2003**, 402, 57-67.  
 - R. Cerc Korošec, P. Bukovec: The role of thermal analysis in optimization of the electrochromic effect of nickel oxide thin films, prepared by the sol-gel method. Part 2. - *Thermochim. acta* **2004**, 410, 65-71.  
 - R. Cerc Korošec, P. Kajič, P. Bukovec: Determination of water, ammonium nitrate and sodium nitrate content in »water-in-oil« emulsions using thermogravimetry and dynamic scanning calorimetry. - *J. therm. anal. calorim.* **2007**, 89, 619 – 624.