MASTER OF SCIENCE IN CHEMISTRY

Master of Science in Chemistry – Curriculum

Outline

Natural science requirements 11 credits
Compulsory core courses 43 credits
Industrial training I – Project work 5 credits
Elective chemistry courses 25 credits
Thesis 30 credits
Elective general courses – can be chemistry related as well 6 credits

Total: 120 credits

Details

I. Natural science requirements 11 credits

Mathematics 7 credits

<table>
<thead>
<tr>
<th>Courses</th>
<th>ECTS</th>
<th>Hours</th>
<th>Type</th>
<th>Responsible department</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematical chemistry</td>
<td>4</td>
<td>2</td>
<td>l</td>
<td>AKKT</td>
<td>Tasi, Gyula</td>
</tr>
<tr>
<td>Mathematical chemistry practical</td>
<td>3</td>
<td>2</td>
<td>s</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Informatics 2 credits

<table>
<thead>
<tr>
<th>Courses</th>
<th>ECTS</th>
<th>Hours</th>
<th>Type</th>
<th>Responsible department</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical information retrieval</td>
<td>2</td>
<td>2</td>
<td>s</td>
<td>SzKT</td>
<td>Pálinkó, István</td>
</tr>
</tbody>
</table>

Physics 2 credits

<table>
<thead>
<tr>
<th>Courses</th>
<th>ECTS</th>
<th>Hours</th>
<th>Type</th>
<th>Responsible department</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced experimental physics</td>
<td>2</td>
<td>2</td>
<td>l</td>
<td>FTCs</td>
<td>Hopp, Béla</td>
</tr>
</tbody>
</table>
## II. Compulsory core courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Lectures</th>
<th>Seminar</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inorganic chemistry</strong></td>
<td>6 credits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced inorganic chemistry</td>
<td>4</td>
<td>2</td>
<td>l</td>
<td>SzAKT Gajda, Tamás</td>
</tr>
<tr>
<td>Advanced inorganic chemistry seminar</td>
<td>2</td>
<td>1</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td><strong>Physical chemistry</strong></td>
<td>11 credits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced physical chemistry</td>
<td>4</td>
<td>2</td>
<td>l</td>
<td>FKAT Tóth, Ágota</td>
</tr>
<tr>
<td>Advanced physical chemistry seminar</td>
<td>2</td>
<td>1</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>Advanced physical and polymer chemistry laboratory practical</td>
<td>5</td>
<td>5</td>
<td>s</td>
<td>FKAT Peintler, Gábor</td>
</tr>
<tr>
<td><strong>Organic chemistry</strong></td>
<td>8 credits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced organic chemistry</td>
<td>6</td>
<td>4</td>
<td>l</td>
<td>SzKT Pálinkó, István</td>
</tr>
<tr>
<td>Advanced organic chemistry seminar</td>
<td>2</td>
<td>1</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td><strong>Analytical chemistry</strong></td>
<td>7 credits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modern instrumental analytical chemistry</td>
<td>5</td>
<td>3</td>
<td>l</td>
<td>SzAKT Galbács, Gábor</td>
</tr>
<tr>
<td>Modern instrumental analytical chemistry seminar</td>
<td>2</td>
<td>1</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td><strong>Industrial chemistry</strong></td>
<td>11 credits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit operations</td>
<td>4</td>
<td>2</td>
<td>l</td>
<td>AKKT Kukovecz, Ákos</td>
</tr>
<tr>
<td>Unit operations practical</td>
<td>3</td>
<td>2</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>Industrial training (4 weeks)</td>
<td>4</td>
<td>0</td>
<td>s</td>
<td>AKKT Kukovecz, Ákos</td>
</tr>
</tbody>
</table>
III. Elective general courses 6 credits

<table>
<thead>
<tr>
<th>Course</th>
<th>Semester</th>
<th>Type.</th>
<th>ECTS</th>
<th>Responsible Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematical chemistry</td>
<td>2</td>
<td>l</td>
<td>4</td>
<td>AKKT</td>
</tr>
<tr>
<td>Mathematical chemistry practical</td>
<td>2</td>
<td>s</td>
<td>3</td>
<td>AKKT</td>
</tr>
<tr>
<td>Advanced experimental physics</td>
<td>2</td>
<td>l</td>
<td>2</td>
<td>FTCs</td>
</tr>
<tr>
<td>Chemical information retrieval</td>
<td>2</td>
<td>s</td>
<td>2</td>
<td>SzKT</td>
</tr>
<tr>
<td>Advanced physical chemistry</td>
<td>2</td>
<td>l</td>
<td>4</td>
<td>FKAT</td>
</tr>
<tr>
<td>Advanced physical chemistry seminar</td>
<td>1</td>
<td>s</td>
<td>2</td>
<td>FKAT</td>
</tr>
<tr>
<td>Advanced physical and polymer chemistry laboratory</td>
<td>5</td>
<td>s</td>
<td>5</td>
<td>FKAT</td>
</tr>
<tr>
<td>Advanced inorganic chemistry</td>
<td>2</td>
<td>l</td>
<td>4</td>
<td>SzAKT</td>
</tr>
<tr>
<td>Advanced inorganic chemistry seminar</td>
<td>1</td>
<td>s</td>
<td>2</td>
<td>SzAKT</td>
</tr>
</tbody>
</table>

Subtotal: 4 l, 5 s 19

IV. Thesis 2×15 credits
V. Project work 5 credits
VI. Elective chemistry courses 25 credits

Master of Science in Chemistry – Program Plan

Subtotal: 4 l, 5 s 28
<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
<th>Type</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced organic chemistry</td>
<td>4</td>
<td>l</td>
<td>6</td>
</tr>
<tr>
<td>Advanced organic chemistry seminar</td>
<td>1</td>
<td>s</td>
<td>2</td>
</tr>
<tr>
<td>Modern instrumental analytical chemistry</td>
<td>3</td>
<td>l</td>
<td>5</td>
</tr>
<tr>
<td>Modern instrumental analytical chemistry seminar</td>
<td>1</td>
<td>s</td>
<td>2</td>
</tr>
<tr>
<td>Unit operations</td>
<td>2</td>
<td>l</td>
<td>4</td>
</tr>
<tr>
<td>Unit operations practical</td>
<td>2</td>
<td>s</td>
<td>3</td>
</tr>
<tr>
<td>Project work</td>
<td>5</td>
<td>s</td>
<td>5</td>
</tr>
<tr>
<td><strong>Subtotal: 3 l, 4 s</strong></td>
<td><strong>18</strong></td>
<td></td>
<td><strong>27</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
<th>Type</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Training</td>
<td>-</td>
<td>s</td>
<td>4</td>
</tr>
<tr>
<td>The cultural history of chemistry</td>
<td>2</td>
<td>l</td>
<td>3</td>
</tr>
<tr>
<td>Thesis 1</td>
<td>15</td>
<td>s</td>
<td>15</td>
</tr>
<tr>
<td><strong>Subtotal: 1 l, 2 s</strong></td>
<td><strong>17</strong></td>
<td></td>
<td><strong>22</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
<th>Type</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thesis 2</td>
<td>15</td>
<td>s</td>
<td>15</td>
</tr>
<tr>
<td><strong>Subtotal: 1 s</strong></td>
<td></td>
<td></td>
<td><strong>15</strong></td>
</tr>
<tr>
<td><strong>Total: 7 k, 13 g</strong></td>
<td></td>
<td></td>
<td><strong>92</strong></td>
</tr>
</tbody>
</table>

20 credits out of the 25 credits from the elective chemistry courses will be available in semesters 3 and 4.
## Elective chemistry courses

### Pharmaceutical researcher specialisation – Gajda, Tamás

<table>
<thead>
<tr>
<th>Subject</th>
<th>Credits</th>
<th>ECTS</th>
<th>Department</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biocatalysis</td>
<td>4</td>
<td>2</td>
<td>SzAKT</td>
<td>Gajda, Tamás</td>
</tr>
<tr>
<td>Biological tools of modern chemistry</td>
<td>4</td>
<td>2</td>
<td>SzAKT</td>
<td>Gyrucsik, Béla</td>
</tr>
<tr>
<td>Fundamentals of pharmaceutical chemistry</td>
<td>5</td>
<td>3</td>
<td>SzAKT</td>
<td>Kiss, Tamás</td>
</tr>
<tr>
<td>Bioorganic chemistry</td>
<td>4</td>
<td>2</td>
<td>SzKT</td>
<td>Wölfling, János</td>
</tr>
<tr>
<td>Chemistry of organometallic compounds</td>
<td>4</td>
<td>2</td>
<td>SzKT</td>
<td>Mastalír, Ágnes</td>
</tr>
<tr>
<td>Natural organic compounds, organic syntheses</td>
<td>4</td>
<td>2</td>
<td>SzKT</td>
<td>Wölfling, János</td>
</tr>
<tr>
<td>Synthetic chemistry laboratory</td>
<td>6</td>
<td>6</td>
<td>KTCS</td>
<td>Bucsi, Imre</td>
</tr>
</tbody>
</table>

| 31 19 |

### Material science researcher specialisation – Kónya, Zoltán

<table>
<thead>
<tr>
<th>Subject</th>
<th>Credits</th>
<th>ECTS</th>
<th>Department</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macromolecular systems</td>
<td>4</td>
<td>2</td>
<td>FKAT</td>
<td>Szabó, Tamás</td>
</tr>
<tr>
<td>Electrochemical procedures, corrosion</td>
<td>4</td>
<td>2</td>
<td>FKAT</td>
<td>Szűcs, Árpád</td>
</tr>
<tr>
<td>Nanocomposites</td>
<td>4</td>
<td>2</td>
<td>AKKT</td>
<td>Kónya, Zoltán</td>
</tr>
<tr>
<td>Interfaces and nanostructures</td>
<td>5</td>
<td>3</td>
<td>FKAT</td>
<td>Dékány, Imre</td>
</tr>
<tr>
<td>Heterogeneous catalysis</td>
<td>4</td>
<td>2</td>
<td>AKKT</td>
<td>Hernádi, Klára</td>
</tr>
<tr>
<td>Bulk and surface methods of material characterisation</td>
<td>4</td>
<td>3</td>
<td>AKKT</td>
<td>Kónya, Zoltán</td>
</tr>
<tr>
<td>Bulk and surface methods of material characterisation, seminar</td>
<td>1</td>
<td>1</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>Solid-state chemistry</td>
<td>4</td>
<td>2</td>
<td>FKAT</td>
<td>Oszkó, Albert</td>
</tr>
</tbody>
</table>

| 30 17 |

### Analytical chemist specialisation – Galbács, Gábor

<table>
<thead>
<tr>
<th>Subject</th>
<th>Credits</th>
<th>ECTS</th>
<th>Department</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analytical sensors</td>
<td>4</td>
<td>2</td>
<td>SzAKT</td>
<td>Galbács, Gábor</td>
</tr>
<tr>
<td>Laser- and plasma-based trace analysis</td>
<td>4</td>
<td>2</td>
<td>SzAKT</td>
<td>Galbács, Gábor</td>
</tr>
<tr>
<td>Modern chromatographic methods</td>
<td>4</td>
<td>2</td>
<td>SzAKT</td>
<td>Ilisz, István</td>
</tr>
<tr>
<td>Analytical quality assurance and quality</td>
<td>4</td>
<td>2</td>
<td>SzAKT</td>
<td>Schrantz, Krisztina</td>
</tr>
</tbody>
</table>
control systems

Molecular spectroscopy | 4 | 2 | FKAT | Berkesi, Ottó
Separation methods and spectroscopy laboratory | 4 | 4 | SzAKT | Ilisz, István
Chemometry | 2 | 2 | KTCs | Jakusch, Tamás
Isotope technology | 4 | 2 | FKAT | Oszkó, Albert

30 18

Electives without specialisation

Modern quantum chemistry | 4 | 2 | AKKT | Tasi, Gyula
Computational chemistry | 4 | 2 | AKKT | Tasi, Gyula
Computational chemistry seminar | 3 | 2 | AKKT
Computational modeling in material and pharmaceutical research | 4 | 2 | FKAT | Czakó, Gábor
Nonlinear dynamics | 4 | 2 | FKAT | Tóth, Ágota
Physical inorganic chemistry | 4 | 2 | SzAKT | Jakusch, Tamás
X-ray diffractometry | 4 | 2 | AKKT | Sápi, András
Graphite wires and carbon nanotubes | 4 | 2 | AKKT | Hernádi, Klára
Chemistry of non-aqueous solutions and melts | 4 | 2 | SzAKT | Sipos, Pál

31 18

Total: 122 credits (106 credits lectures, 16 credits seminars/laboratory practicals)

To fulfill the requirement of a specialisation at least 20 credits out of the listed electives must be collected.
Course title: Analytical Quality Assurance and Quality Control Systems

Credits: 4

Course description:


Literature:

Course title: Analytical Sensors

Credits: 4

Course description:

Definition and classification of sensors and transducers. Physical, chemical and biosensors. Functions and applications of sensors and transducers in analytical chemistry and automated measurement systems. Construction and principle of operation of relevant modern sensor types including electrochemical (e.g., potentiometric and voltammetric) and photometric (absorptive, reflective and luminescence) types, as well as sensors used for the detection/measurement of mass, temperature, pressure, liquid/gas flow, with special emphasis on semiconductor and fiber optic based sensors. Practical examples for the measurement of pH, the concentration of metal ions in solutions, noxious gases and some compounds with a diagnostic value. Sensors in portable, remotely manageable and miniaturized measurement systems.

Literature:

Course title: Biocatalysis

Credits: 4

Course description:

Introduction, basic principles and historical survey. The origin of enzymatic efficiency and (stereo)selectivity. Applications of enzyme inhibitors in medicine. Comparison of chemical and biological catalysis. Dynamic and kinetic resolution. The possibilities of the realisation of biocatalytic reactions.


Modified enzymes. The evolution of enzymes. Improvement of the temperature, pH etc. resistance of enzymes, changing of regioselectivity and development of new functions by point-mutation and directed evolution. Effects achieved by the change of metal ions in the active centres of metalloenzymes (increased activity, change of the function, etc.). Introducing specificity into a non-specific enzymes and vica versa. Development of new enzymes by covalent coupling of proteins and simple metal complexes (Cu/Fe-containing nuclease, asymmetric synthesis by Ru/Rh-containing artificial enzymes, etc.).

Biomimetic catalysis. Catalytic properties of metal ions, some basic principles of the design of artificial enzymes.

Artificial hydrolases: Artificial phosphatases and nuclease. The active centres. Substrate selectivity and the role of allosteric groups. The importance of oligonuclear active centres. Possible application in gene technology and gene specific chemotherapy.


Literature:

Course title: Biological Tools in Modern Chemistry

Credits: 4

Course description:

The overlap of the chemical and biological sciences. The effect of molecular biology on the development of chemistry. The cell. The role of given metal ions and metalloenzymes within the organisation of living cell, and in the biochemical processes. Examples of the role of the metalloenzymes, metalloproteines, and the “free” metal ions.


The basics of gene technology. The different pathways of the enzyme or protein modifications, examples. The design of new macromolecules. The polymerase chain reaction. The design and synthesis of artificial DNA vectors. Viruses, as DNA carriers. Bacteria in DNA cloning. DNA synthesis within the cell. The analysis of DNA – sequence determination.


Literature:


The lecture is, beside the above book based on the handbooks used in molecular biology laboratories, as well as on the scientific papers published in international journals. These new results allow for the continuous modernization of the topics.
Course title: Bioorganic Chemistry

Credits: 4

Course description:


Amino-carboxylic acids, peptides, polypeptides and proteins. The classification of amino acids, their structures, chiralities, synthesis methods, physical and chemical properties. The reactions of the their functional groups. The nomenclature of di- and polypeptides, methods of synthesis (protecting and activating groups, coupling agents). The synthesis of ring peptides. Scission of the peptide bonds by chemical and enzymatic means. The structure, structural characterization, physical and chemical properties of polypeptides and proteins. The primary, secondary, tertiary and quaternary structures of proteins.


Literature:

Course title: Bulk and Surface Methods of Material Characterisation

Credits: 4 + 1

Course description:

Structure and bonding of materials: XRD, electron diffraction, neutron scattering, XPS, UV-Vis, micro-CT, dielectric spectroscopy. The concept of equivalent networks and its correlation with the inner structure of matter.
The concept of porosity. Descriptors used for the quantitative characterization of pore systems. Adsorption methods, mercury porosimetry, SAXS.
Industrial characterization of powders and coatings: colour and thickness measurements, particle size distribution analysis.
Physical and mechanical properties: heat transfer coefficient, Young’s modulus, tensile strength, hardness.
Thermoanalytics: TG, DTA, DSC.
Common material defects and their identification in composites, alloys and welds.
The fundamentals of microscopy: definition of the image, imaging methods, image processing.
Quantitative descriptors of morphology: fractal dimension, lacunarity, shape factors.
Known limitations of microscopic methods: what can you expect and what not?

Literature:

I. Pozsgai: Scanning electron microscopy and microanalysis (ELTE Eötvös Kiadó, Budapest, 1995)
I. Pozsgai: The fundamentals of analytical electron microscopy (ELTE Eötvös Kiadó, Budapest, 1996)
K. Burger: Fundamentals of quantitative analysis: Chemical and instrumnetal analysis (Semmelweis Kiadó, Budapest, 1992)
Course title: Chemometrics

Credits: 4

Course description:
Correct statistical interpretation of chemical measurements. Relationship of chemical quantities. The task of calibration. Deriving kinetic and thermochemical parameters from chemical measurements

Literature:
Course title: Computational Chemistry

Credits: 4

Course description:


Literature:

J. Frank, Introduction to Computational Chemistry, John Wiley & Sons, Chichester, 1999
A. Hinchliffe, Modelling Molecular Structures, John Wiley & Sons, Chichester, 2000
C. Christopher, Essentials of Computational Chemistry, John Wiley & Sons, Chichester, 2002
Course title: Fundamentals of Medicinal Chemistry

Credits: 4

Course description:

Introduction, basic concepts.
Routes of the drug inside the organism: pharmacokinetic phase.
Original drug design and development.
Stereochemistry and drug design.
Drug solubility and its modification by pharmaceutical technological methods.
Drug action that affects the structure of cell membranes and walls.
Proteins I: Enzymes and drug design.
Proteins II.: Receptors and drug design.
Drugs that target nucleic acids.
Factors that modify the effects of drugs.
Metal compounds applied in therapy.
Diagnostic agents. Disorders in metal ion balance, Chelating therapy.
Toxicology of metals I.
Toxicology of metals II.

Literature:

Course title: Heterogeneous Catalysis

Credits: 4

Course description:

Fundamental concepts of reaction kinetics.
Synthesis methods of heterogeneous catalysts.
Temperature-programmed reduction and temperature-programmed reduction.
Characterisation of heterogeneous catalysts with chemical and instrumental methods.
Types of catalysts.
Catalysis by porous materials.
Photocatalysts and photocatalytic reactions.
Biomimetic catalysts.
Application of heterogeneous catalysts in fine chemical syntheses.
Industrial applications of heterogeneous catalysts.

Literature:

**Course title:** Interfaces and Nanostructures

**Credits:** 4

**Course description:**

The role of interfaces on the properties of nanostructured materials. The Kelvin equation. The optical, magnetic, semiconducting and catalytic properties of nanoparticles.


The tension of curved surfaces. The Laplace and Kelvin equations. Capillary condensation and the Ostwald ripening.


Instrumental methods for the characterisation of nanostructured materials (TEM, SEM, STM, AFM, SAXS, SPR, ellipsometry, QCM). Application of sensors for measuring interactions at the interface. Interfacial adsorption (S/L) of non-electrolytes (binary liquid mixtures and dilute solutions. Types of isotherms, their measurements and their analysis. Hydrophilic and hydrophobic surfaces. The adsorption layer as nanophase reactor.


Self-assembling of surfactants in solution and at interfaces.

Liquid/liquid (L/L) interfaces. The syntheses and properties of emulsions, nanoemulsions and microemulsions. Microemulsions as nanophase reactors.

Fundamental concepts of rheology, the rheological properties of disperse systems. Classification of the flow curves. Newtonian and structural-type viscosities. Thixotropy. The rheological behaviour of concentrated suspensions and their measuring possibilities.

Coherent systems. The gels. The structure of coherent systems, the role of gels in medicine formulation.

Literature:


Course title: Laser and Plasma-based Analytical Methods

Credits: 4

Course description:

Principle of operation, analytical and operational characteristics as well as primary application areas for laser and/or plasma-based analytical methods are discussed. Not only laboratory-based measurement systems, but also portable, miniature, remotely controllable and those that can work from a stand-off distance are covered. The following list gives an overview of the covered topics.

- Characteristics of laser light sources
- Application possibilities of lasers in analytical chemistry
- Plasma atom/ion sources (DCP, MIP, CCP, ICP, DBD, etc.)
- Plasma diagnostics using lasers
- Modulation and high resolution laser spectroscopic methods
- Laser-induced fluorescence spectroscopy (LIF)
- Laser ablation (LA) and laser-induced plasma spectroscopy (LIBS/LIPS)
- Matrix-assisted laser desorption mass spectroscopy (MALDI)
- Inductively coupled plasma mass spectrometry (ICP-MS)
- Resonance ionisation spectroscopy (LEI/RIS/RIMS)
- Cavity ring-down spectroscopy (CRDS)
- Photoacoustic spectroscopy (PAS)

Application of lasers in remote measurement systems (e.g., LIDAR, LIBS, RiID)

Literature:


**Course title:** Macromolecular Systems

**Credits:** 4

**Course description:**

Classification of macromolecules. The structural features of macromolecules and their physical properties. Synthesis methods of polymers, various types of polymerisation reactions. Photopolymerisation technologies.

Models of linear polymer chains. Solvation and dissolution of polymers. The thermodynamics of polymer solution, the Flory-Huggins theory.


The osmotic pressure and the thermodynamics of solvation for macromolecular solutions.

The properties of polyelectrolytes – the effects of pH and the ionic strength.

The adsorption of polymers over solid surfaces.

The stabilities of colloid dispersions in polymer solutions – steric stabilisation.


Mechanical and rheological properties of polymers. Determining the viscosities and molecular weights of polymer solutions. The Maxwell and the Voight-Kelvin model.

Application areas of polymers. Plastics and polymer composites.

Swelling of 3D polymers, the structure of polymer gels, intelligent 3D polymers.

Polymer films and coatings. Films from solutions, dispersions and melts.

**Literature:**


**Course title:** Modern Quantum Chemistry

**Credits:** 4

**Course description:**


**Literature:**

A. Böhm, *Quantum Mechanics*, Springer-Verlag, 1979
Course title: Nanocomposites

Credits: 4

Course description:

Nanocomposites: past and future
What is a nanocomposite?
Nanocomposites: past and present
Myths
Nomenclature
Introduction to solids
Atomic and molecular solids
Primary, secondary and tertiary structure
Effect of scale
Properties
Composites and nanocomposites
Surface mechanical properties
Rubbery, elasticity and viscoelasticity
Diffusion and permeability
Features of nanocomposites
Nanoreinforcements
Matrix materials
Role of particle size
Synthesis of nanocomposites
Solvent-free processing (viscosity, non-Newtonian flow, etc.)
Solvent processing, in situ polymerization
Thermo-kinetic processes
Characterization of nanocomposites
Methods for characterization
Structure characterization (texture, scales in nanocomposites, physicochemical analysis, etc.)
Physical properties (Mechanical properties, Barrier Properties etc.)
Nanocomposites in nanotechnology
Nanocomposites for special applications (high T)

Literature:

T.E. Twardowski, Introduction to Nanocomposite Materials (Properties, Processing, Characterization)
J. Koo, Polymer Nanocomposites
I. Capek, Nanocomposite structures and dispersions
Course title: Natural Organic Compounds, Methods of Syntheses

Credits: 4

Course description:

Hormones of vertebrates.
Prostane derivatives and leukotrienes. Modified prostaglandin derivatives, prostaciklines, tromboxanes. The biotransformations of leukotrienes.
Phenylpropane derivatives. Flavonoids, antoxantins and antocyanins.
Polyketides. Cannabinoids, melanines.
Alkaloids. Antibiotics.

Methods for the preparation of C−C bonds.
Methods for the preparation of C−heteroatom bonds.
Synthesis strategies.
Retrosynthetic analysis, concepts disconnection and synthon.
Synthons of carbon chains and carbocycles.
Reactions with organometallic compounds and stabilised carbanions.
Reduction and oxidation reactions.
Construction and removal of protecting groups.
Microwave-assisted syntheses.
Methods of green chemistry and catalysis in organic syntheses.

Literature:

Course title: Nonlinear Dynamics

Credits: 4

Course description:


Spatiotemporal patterns: fronts and waves. Target patterns, spirals.


Literature:


Course title: Organometallic Chemistry

Credits: 4

Course description:

Classification and nomenclature of organometallic compounds. Preparation, structural properties, chemical reactions and practical applications of organometallic compounds of
- ionic character (organometallics with alkali and alkali earth metals),
- polar character (organozinc and organocupper compounds),
- covalent character (organoboron compounds).
Classification and nomenclature of transition metal complexes. Formation, structural characteristics and chemical reactions of transition metal complexes
- alkyl and aryl complexes,
- metal hydrides,
- carbonyl and phosphine complexes,
- alkene and alkyne complexes,
- allyl complexes,
- diene complexes.
Transformations of transition metal complexes,
- oxidative addition and reductive elimination,
- insertion and β-elimination,
- nucleophilic and electrophilic addition.

Applications of transition metal complexes in the syntheses of organic intermediates and fine chemicals. The general principles of homogeneous catalysis. Applications of transition metal complexes as homogeneous catalysts in organic syntheses. Enantioselective reactions catalysed by chiral transition metal complexes, kinetic resolution.
Course title: Separation Techniques

Credits: 4

Course description:

Literature:
G.D. Christian, J.E. O'Reilly: Instrumental Analysis
G.W. Ewing: Instrumental methods of chemical analysis