Surface phenomena and catalysis

- surface tension,
- Langmuir – Blodgett film,
- physisorption and chemisorption,
- wetting and contact angle
- homogenous and heterogeneous catalysis
- application of catalytic method for cleaning of exhaust gases
- biocatalysis

Processing of polymeric materials

- extrusion of polymeric materials,
- injection moulding,
- blow moulding,
- rheology,

Engineering of chemical reactors

- designing an industrial process using ChemCAD,

Modelling and simulation

- simulation of reactants flow within main reactor using ANSYS,

Selected aspects of modern chemistry

- ionic liquids
- sol-gel method
- metal-organic framework (MOF)- properties & application
- layered double hydroxide (LDH)- properties & application

Advanced Materials for Energy Storage/Conversion

- primary and secondary cells
- electrochemical capacitors
- lithium-ion batteries
- redox flow battery
- fuel cells

Nanocarbons and Carbon/Polymer Composites

- carbon nanotubes: preparation method, properties, application
- graphene: synthesis, properties
- composites with conducting polymers

Polymers

- Basic concepts: linear, branched and crosslinked polymers, molecular weight, tacticity.
- Basic characteristics of chain polymerization reaction: types, mechanisms, examples of polymers.

- Copolymerization and copolymers (types, examples).
- Basic characteristics of step polymerization; mechanism, examples of polymers.
- Polymer morphology.
- Classification of polymeric materials (thermoplastics, thermosets, elastomers, thermoplastic elastomers – examples).
- Polymer blends, examples.
- Commodity, engineering and performance polymers.
- Thermal properties of polymers (thermal transitions, DSC measurements).
- Mechanical properties of polymers (tensile properties, stress-strain behavior).
- composites,
- matrix composites materials,
- resins,
- application and production of composites

Applied Rheology

- rheological models,
- magnetorheological fluids,
- Newtonian and non-Newtonian flow

Biotechnology

- GMO,
- cell immobilization,
- beer production,
- biofuel,
- biohazards in the environment

Engineering of nanoporous materials

- drying,
- porosity and permeability,
- Darcy's law,
- application and production of nanoporous materials,
- properties of nanoporous materials

Green chemistry

- rules of green chemistry,
- main advantages of green chemistry,
- sustainability in industry,
- ionic liquids as green chemistry solvents

Recycling

- recycling of polymeric materials,
- biodegradable materials

Hybrids and fillers

- definition and application of fillers,
- definition of hybrids,

- production of hybrids materials,
- silica and its production, application and properties,
- titania and its production, application and properties,
- magnesium oxide and its production, application and properties

Characterization techniques

- Nature of electromagnetic radiation,
- X-ray production,
- X-ray absorption and emission,
- x-ray diffraction
- NMR spectroscopy,
- XPS spectroscopy,
- porosity and surface area study

Biomaterials

- Ceramic biomaterials.
- Composite materials in biomaterials engineering.
- Alginates in medical applications.
- Carbon fibers and carbon materials in medicine.
- Medical sterilization.
- *In vivo* and *in vitro* methods in biomaterials testing.
- Osteosynthesis.
- The methods of evaluation of dental filling-tooth interface.
- The methods of assessment of bioactivity of biomaterials.
- The methods of scaffold formation.
- Memory shape alloys.
- Memory shape polymers.
- Additives used in dental composite (example: antibacterial, color stabilizers, etc.)