Subject Areas for MSc. Admission Exams

An applicant for MSc study at the Faculty of Chemical Technology should have the knowledge of Chemistry, Technology, and Material Science, which is comparable to bachelors graduating at this faculty. Different specializations of the Chemistry, Technology and Materials study program focus on different aspects of Chemistry and other technical sciences, so that the admission exams are organized according to the student specialization into several subject areas. However, the list is not limiting, and it is only to describe the focus of admission exam. The examination discussion may require the general knowledge of other disciplines at the most rudimentary bachelor level as well.

Study program Chemistry, Technology and Materials

Specialization Chemistry and Chemical Technology (focus on Inorganic, Organic or Macromolecular Chemistry)

2 compulsory subject areas:

- General and Inorganic Chemistry
- Organic chemistry

1 of 2 compulsory-optional subject areas:

- Macromolecular chemistry
- Physical chemistry

Subject area „General and Inorganic Chemistry“

1. Structure of substances. Structure of atom.
2. Periodic law and the periodic system of elements.
3. Chemical bond and chemical reactions.
4. Non-metal elements. Chemical bonding, properties, and reactivity.
5. Polyatomic molecules of non-metals - structure, chemical bonding, and properties.
6. Gaseous and liquid molecular compounds of non-metals.
7. Monoatomic ions in an aqueous solution and their salts.
8. Oxyanions in an aqueous solution or crystals.
9. Coordination compounds.
10. Structure, chemical bonding, and properties of metals.
11. Metals and intermetallic phases - reactivity, extraction, and use.
12. Solid oxides and inorganic polymers.
13. Binary solid compounds of metals and non-metals.
14. Phases and species of chalcophilic environments.

Subject area „Organic Chemistry“

1. Alkanes and cycloalkanes. Structure, reactivity. Stereochemistry of alkanes and cycloalkanes.
2. Alkenes, structure, and reactivity. Electrophilic and radical addition reactions, stability of carbocations and radicals. Stereochemistry of alkenes.
3. Alkynes. Acidity of alkynes, formation of acetylides, alkylation of acetylides. Reactivity of the triple bond in addition reactions.
4. Haloalkanes, structure and properties. Nucleophilic substitution reactions, mechanisms. Stereochemical aspects of nucleophilic substitutions.

5. E1 and E2 elimination reactions and their relation to nucleophilic substitution reactions. Dehydrohalogenation and dehydration reactions.
6. Conjugated multiple bonds. Allyl cations, dienes, their stereo-chemistry, and reactivity.
7. Aromatic hydrocarbons. Aromaticity, electrophilic substitution reactions, mechanism. Fundamental substitution reactions.
8. Alcohols and phenols. Structure, acidity, reactions with nucleophiles. Dehydration and oxidation of alcohols.
9. Carbonyl compounds. Structure, nucleophilic addition reactions to carbonyl group. Carbonyl condensations.
10. Carboxylic acids and their derivatives. Structure, acidity, nucleophilic acyl substitution reactions.

Subject area „Macromolecular chemistry“

1. Introduction and historical development, nomenclature of polymers.
2. Structure of macromolecules, molecular weight.
3. Molecular structure and properties of polymers.
4. Polymerizability of low molecular substances.
5. Free radical polymerization - elemental reactions.
6. Kinetics of free radical polymerization.
7. Free radical copolymerization.
8. Ionic polymerization and copolymerization.
9. Insertion polymerization, polymerization practice.
10. Ring-opening polymerization.
11. Step-growth polymerization - characterization, reactivity of monomer functional groups.
12. Polycondensation - mechanism and kinetics, molecular weight distributions.
13. Polyadditions - typical syntheses.
14. Reactions of polymers.

Subject area „Physical Chemistry“

1. Basic terminology, thermodynamic system, thermodynamic process, state properties.
2. State behaviour of gases, equation of state of ideal gas. Real gas and its behaviour.
3. 1st law of thermodynamics. Internal energy, heat, work.
4. Enthalpy, heat of reaction, standard enthalpy of formation. Hess and Kirchhoff's laws.
5. 2nd law of thermodynamics, entropy. Entropy changes on selected processes.
6. Helmholtz and Gibbs energy, their significance. 3rd law of thermodynamics.
7. Partial molar quantities, activity, chemical potential, standard states.
8. Phase equilibria in single-component systems, Clapeyron equation.
9. Gibbs phase law, vapour-liquid equilibrium in ideal systems, phase diagrams.
10. Solubility of gases in liquids, equilibria in condensed systems.
11. Material balance of chemical reactions. Equilibrium constant. Equilibria in electrolyte systems.
12. Equilibrium composition. Reactions in gaseous phase.
13. Faraday´s law, galvanic cells, Nernst equation.
14. Basic terms of chemical kinetics, reaction rate, integration of rate equation

Subject Areas for MSc. Admission Exams

Study program Chemistry, Technology and Materials

Specialization Chemistry and Chemical Technology (focus on Chemical Technology)

2 compulsory subject areas:

- Chemical Engineering
- Physical chemistry

1 of 2 compulsory-optional subject areas:

- General and Inorganic Chemistry
- Organic chemistry

Subject area „Chemical Engineering“

1. Basic terminology. Systems. Principles of balancing. Mass and mole balance.
2. Balance of energy. Bernoulli equation.
3. Flow of fluid through pipes. Transport of fluids, pumps. Flow of fluid through porous medium.
4. Filtration, types of filters, filtration rate.
5. Balance of enthalpy.
6. Heat transfer, transfer coefficient. Heat exchange by conduction and convection.
7. Heat exchangers: types and design. Evaporators: types and design.
8. Diffusion separation processes. Mass transfer equipment. Equilibrium plate.
9. Liquid extraction of immiscible solvents: equipment, single-stage, repeated and countercurrent extraction.
10. Flash and differential distillation of binary mixtures.
11. Rectification in staged column.
12. Drying of solids, enthalpic humidity chart. Batch and continual dryers.
13. Chemical reactors and bioreactors, basic types. Material balance.
14. Chemical process equipment.

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Study program Chemistry, Technology and Materials

Specialization Materials Chemistry and Technology

2 compulsory subject areas:

- Materials Science
- Physical chemistry

1 of 3 compulsory-optional subject areas:

- General and Inorganic Chemistry
- Organic chemistry
- Macromolecular Chemistry

Subject area „Materials Science“

1. Materials – definition, classification
2. Iron – production, classification of iron alloys
3. Steel, cast iron – properties, important types
4. Nonferrous alloys – based on Al, Cu, Zn, Pb, Mg, Ti, Ni and precious metals.
5. Glass – production, properties, types
6. Ceramics – production, properties, types
7. Inorganic binders – production, properties, types
8. Semiconductors, carbon-based materials
9. Polymeric materials – types, structure, properties, production
10. Termoplastics
11. Thermosets, elastomers
12. Composite materials – classification, properties, production
13. Mechanical properties of materials
14. Physical and chemical properties of materials

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14. Reactions of polymers.

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Study program Chemistry

Specialization Organic Chemistry

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- Organic Chemistry
- General and Inorganic Chemistry
- Physical Chemistry

Subject area „Organic Chemistry“

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