TOPICS OF FINAL MASTER EXAMINATION
DEPARTMENT OF INORGANIC TECHNOLOGY
(3 compulsory subjects and 1 optional)

Subject 1-compulsory

Inorganic Technology

1. Production of sulphuric acid from sulphur, conditions of sulphur dioxide catalytic oxidation, conversion of sulphur dioxide by double contact process, absorption of sulphur trioxide
2. Production of synthesis gas from gaseous and liquid raw materials, synthesis loop of ammonia production
3. Production of nitric acid, catalytic oxidation of ammonia, absorption of NO_x gases and their removal from tail gases
4. Sodium carbonate production – ammonia-sodium carbonate process
5. One-component nitrogen-containing fertilizers
6. Raw materials for phosphorus chemistry, production of phosphorus, production of furnace- and wet-process orthophosphoric acid, phosphorus-containing fertilizers
7. Production of multi-component fertilizers
8. Electrolysis of water, hydrogen and oxygen production
9. Hydrogen economy, production, transport and storage of hydrogen, energy conversion
10. Chlor-alkali electrolysis – mercury process
11. Chlor-alkali electrolysis – membrane and diaphragm process
12. Chlorine compounds and their production
13. Electrochemical and chemical deposition of metals, basic components of electrodeposition bath, influence of operating conditions on layer quality, treatment of process and waste water
14. Alumina (Al_2O_3) production, theory and technology of aluminium (Al) production

Subject 2-compulsory

Physicochemical Principles of Inorganic Technology

1. Solubility in two- and three-component systems
2. Solubility in four-component systems
3. Application of thermodynamic functions G, F, H, U, S in inorganic technology
4. Calculation of fugacity and activity in real systems, state behaviour of real gases
5. Calculation of equilibrium composition in gaseous, liquid and heterogeneous systems
6. Relation between the conversion degree and temperature for adiabatic reactions, conversion constraints given by equilibrium
7. Kinetics of elementary reactions, dependence of rate constant on temperature
8. Kinetics of complex reactions, quasi-stationary state, rate-determining step
9. Equilibrium and rate of chemisorption, kinetics and mechanism of catalytic reaction in ideally adsorbed layer
10. Influence of transport phenomena on the rate of chemical reaction
11. Basic laws of electrochemistry
12. Calculation of equilibrium potential, reference electrodes
13. Kinetics of electrode reactions, activation overpotential
14. Concentration overpotential, limiting current density
15. Polarization curves, mixed electrode potential

Subject 3-compulsory

Process Design

1. Mass and enthalpy balances of complex chemical processes
2. Complex chemical process simulation, structure of universal simulation programs
3. Chemical process design: reactor – separator - heat exchanger
4. Selection of chemical reactor, reaction scheme, reactor performance
5. Chemical reactor`s models
6. Processes for homogeneous mixtures separation (rectification, absorption, extraction, membrane separators)
7. Processes for heterogeneous mixtures separation (filtration, cyclones, settling tanks)
8. Design of reactor and separation unit
9. Heat recovery in chemical processes, heat exchangers and their networks

Subject 4-optional (1 from 3 subjects)

a) Technical electrochemistry

1. Transport processes in electrolytes solutions
2. Influence of transport processes on the electrode reaction kinetics
3. Electrolytic cell components (electrodes, separators, electrolyser body)
4. Electrical connection of electrodes (monopolar and bipolar arrangement)
5. Mass transfer in the electrochemical reactors and its intensification
6. Local potential and current density distribution
7. Anodes and cathodes materials
8. Electroplating, surface structure, preparation of products before plating, properties of electrolytes, electrodeposition of alloys
9. Electrochemical methods for metal surface treatment and machining, electrocoating
10. Corrosion and corrosion protection
11. Electrochemical power sources
12. Three-dimensional electrodes
13. Fuel cells
14. Electrolysers for waste water treatment

b) Heterogeneous systems and characterization of solid phase

1. Textural characteristics of porous materials
2. Adsorption on the solid surfaces, theory, types of adsorption isotherms
3. Adsorption methods for specific surface area assesment, Langmuir adsorption isotherm, BET isotherm
4. Pores size distribution by mercury porosimetry
5. Pores size distribution in meso-pores range
6. Pores size distribution in micro-pores range
7. Methods of solids characterization - ESCA, Auger spectroscopy, electron microscopy, electron microprobe (electron probe microanalyzer)
8. Methods of solids characterization - SIMS, TPR, TPD, FTIR, UV-VIS
9. Mass transfer in liquids - film and penetration theories
10. Mechanism of mass transfer in the porous substances

11. Kinetics of nucleation on the solid surface
12. Models of reaction kinetics between solid particles and fluid
13. Model of reaction kinetics between non-porous solid particle and fluid - shrinking core model
14. Description of slow, fast and instantaneous reactions between gas and liquid, procedure of reactor design

c) Membrane processes

1. Basic types of membranes and their characteristics (structure, composition, preparation)
2. Reverse osmosis
3. Ultrafiltration, nanofiltration
4. Microfiltration
5. Membranes for gases separation
6. Pervaporation, membrane distillation
7. Classification of membrane processes according to the driving force
8. Membrane separation processes based on the concentration gradient (osmosis, dialysis)
9. Mass transfer mechanism in membranes
10. Mass flux through ion selective membrane in the presence of electric field
11. Electrodialysis and electrodeionization
12. Membrane as the solid electrolyte for the fuel cells
13. Membrane reactors
14. Electrochemical membrane reactors