

**लोक सेवा आयोग**  
नेपाल इञ्जिनियरिङ्ग सेवा, केमिकल इञ्जिनियरिङ्ग समूह, राजपत्राङ्कित तृतीय श्रेणीको खुला  
प्रतियोगितात्मक लिखित परीक्षाको पाठ्यक्रम

**द्वितीय पत्र :- समूह सम्बन्धी विषय**

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|-----------|---|------------|
| <b>1.</b> | <b>UNIT PROCESS</b>   | <b>10%</b> |
| 1.1       | Introduction and importance of Nitration, Amination by reduction, Halogenation, Sulphonation and sulphation, Amination by ammonolysis   |            |
| 1.2       | Oxidation:<br>Definition and Types, Oxidizing agents, Liquid phase oxidation with oxidizing agents and oxygen. Oxidation of toluene with $MnO_2$ . Mfg. (Manufacturing) of Acetaldehyde from Acetic acid and mfg. of Acetic acid from Ethanol. Vapor phase oxidation of Methanol, Benzene and Naphthalene, Apparatus and its M/s. (Machine) for oxidation reactions |            |
| 1.3       | Hydrogenation<br>Definition and its scope, properties of hydrogen and sources of hydrogen, gas catalytic hydrogenation and hydrogenolysis, factors affecting it, Apparatus and M/c. (Machine), Industrial hydrogenation of fat & oil, Mfg. of Methanol from $CO_2$ & $H_2$  |            |
| 1.4       | Hydrolysis<br>Definition and types of hydrolysis, Hydrolyzing agents, equipment's of hydrolysis, Industrial Hydrolysis of fat, hydrolysis of carbohydrates, starch to dextrose, Mfg. of ethanol from ethylene (shell process) Mfg. of phenol from benzene sulfonic  |            |
| 1.5       | Polymerization<br>Introduction & chemistry of polymerization reactions, classifications of polymers methods of polymerization   |            |
| <b>2.</b> | <b>CHEMICAL PROCESS CALCULATION</b>   | <b>10%</b> |
| 2.1       | Equilibrium relations;  |            |
| 2.2       | Rate laws;  |            |
| 2.3       | Behavior of ideal gases and gaseous mixtures;   |            |
| 2.4       | Vapor pressure;   |            |
| 2.5       | Humidity and saturation;  |            |
| 2.6       | Phase equilibrium;  |            |
| 2.7       | Non-reacting single-phase systems;  |            |
| 2.8       | Systems with recycle, bypass and purge;   |            |
| 2.9       | Processes involving vaporization and condensation;  |            |
| 2.10      | Enthalpy;   |            |
| 2.11      | Heat of reaction;   |            |
| 2.12      | Thermochemistry;  |            |
| 2.13      | Fuel calculations;  |            |
| <b>3.</b> | <b>CHEMICAL ENGINEERING THERMODYNAMIC</b>   | <b>10%</b> |
| 3.1.      | First and Second Laws of Thermodynamics   |            |
| 3.2.      | Volumetric properties of pure fluids  |            |
| 3.3.      | Heat effects  |            |
| 3.4       | Thermodynamics properties of fluids   |            |
| 3.5       | Thermodynamics of flow processes  |            |
| 3.6       | Production of power from heat   |            |
| 3.7       | Solution thermodynamics   |            |
| 3.8       | Phase and chemical-reaction equilibria  |            |

- 4 HEAT TRANSFER 10%**
- 4.1. Modes of Heat Transfer: Fourier conduction equation, General conduction equation in Cartesian, cylindrical and spherical co-ordinates
  - 4.2. Heat Transfer by convection: Fluids with and without phase change, Free & forced convection, laminar & turbulent flows heat transfer inside and outside tubes, concepts of thermal boundary layers, overall heat transfer coefficient, LMTD, fouling factors, transfer units, flow over flat plates with heat transfer, empirical relation
  - 4.3. Boiling phenomena: Regimes of boiling etc.
  - 4.4. Heat Transfer Coefficient models, including boiling and condensation
  - 4.5. Heat Exchangers
  - 4.6. Radiation Heat Transfer
- 5 MASS TRANSFER 10%**
- 5.1. Mass Transfer (M. T.) Co-efficient: in laminar, turbulent flows, theories of M. T., Heat, momentum and mass transfer, analogous
  - 5.2. Introduction to diffusion in solids: Fick's law
  - 5.3. Distillation: VLE data, Flash and simple distillation, continuous, McCabe-Thiele and Ponchon-Savarit method etc.
  - 5.4. Absorption: Equilibrium, material balance for single component transfer, multi-stage & packed tower operation
  - 5.5. Liquid Extraction: Stage wise, Stage type extractor etc.
  - 5.6. Drying Mechanism: Batch drying/ continuous (cont.) Drying
  - 5.7. Crystallization: Equilibrium, Operations, and equipment's
- 6 PROCESS INSTRUMENTATION 10%**
- 6.1. First Principles model development; dynamics of first, second and higher order linear systems,
  - 6.2. Open loop and closed loop systems;
  - 6.3. Linearization;
  - 6.4. Feed back control;
  - 6.5. stability;
  - 6.6. Root locus diagram;
  - 6.7. Frequency response analysis;
- 7 MECHANICAL AND FLUID FLOW OPERATION 10%**
- 7.1. Fluid properties & Dimensional analysis
  - 7.2. Fluid static & its applications
  - 7.3. Friction in pipes & Channels, Pumping of fluids
  - 7.4. Agitation & mixing of liquids
  - 7.5. Solids, characteristics of solid particles, type of standard screen series.
  - 7.6. Size reduction and enlargement, crushers, grinders, disintegrates for coarse & intermediate & fine grinding, energy and power requirements, law of crushers, work index, etc.
  - 7.7. Screening and other separation methods: screen analysis, estimation of particle size, surface area and particle population based on screen analysis, ideal and actual screens, principles of elutriation, flotation, jigging, electrostatics, and magnetic separation processes
  - 7.8. Sedimentation, settling velocity, flocculation etc.
  - 7.9. Fluidizations, dense phase fluidization and boiling beds, Minimum fluidization velocity, minimum (min.) porosity of bed and bed height, batch & cont. fluidization
  - 7.10. Filtration, filter media, filter aids, batch & cont. filtration, filtration equipment, filter press, leaf, cartridge, vacuum filter, rotary drum filters
  - 7.11. Mixing and agitation: equipment's, agitation of liquids, types of impellers, power consumption in agitated vessels etc.
  - 7.12. Conveyers: mechanical and pneumatic conveying, elevators etc.
- 8 CHEMICAL TECHNOLOGY 10%**
- 8.1 Oil and fats
  - 8.2 Soap and detergent and method of manufacturing

8.3	Fermentation of ethyl alcohol and citric acid	
8.4	Starch, Sugar	
8.5	Pulp and paper	
8.6	Leather	
8.7	Cement and lime	
8.9	Ceramic and glass	
8.10	Paints and varnishes	
<b>9</b>	<b>SAFETY ANF POLLUTION CONTROL</b>	<b>10%</b>
9.1.	Concepts and definition of pollution and safety	
9.2.	Occupational health and safety management, ; safety culture; storage of dangerous materials;	
9.3.	Sources of water, air and land pollution; environmental laws & standards; design of pollution Abatement systems for particulate matter and gaseous constituents; hazardous waste disposal and effluent	
9.4.	Solid-waste disposal and recovery of useful products	
9.5.	Modification; recovery of by-products; energy recovery; waste utilization and recycle and reuse. Waste Minimization;	
9.6.	Environmental Policy, Act and Regulations, ISO 14001	
9.7.	Concept of Cleaner Production	
<b>10</b>	<b>QUALITY, STNDARDIZATION AND PRODUCTIVITY</b>	<b>10%</b>
10.1.	Quality and quality control, Quality Circle, Total Quality Management, Quality Management System	
10.2.	Standardization and Certification	
10.3.	Productivity, Kaizen, 5 S	
10.4.	Nepal Standard (Certification Mark) Act 2037, Regulation 2040	
10.5.	Consumer Protection Act	
10.6.	Project Economics	

### विषयगत नमूना प्रश्नहरू (Sample questions)

1. Describe the manufacturing process of industrial alcohol from molasses with the help of a flow chart. Give the reaction of the process (10)
2. Write short notes on the followings: (4 x 2.5 = 10)
  - a. Wet gas meter
  - b. Hot film anemometers
  - c. Magnetic Flow meter
  - d. Pitot Tube
3. a. What is meant by potential flow (2)  
 b. Derive Bernoulli's equation and briefly discuss the components involved in the equation (8)
4. a. Explain the limitations of first law of thermodynamics (4)  
 b. Give any three statements of 2nd law of thermodynamic (6)
5. What do you mean by quality (2)  
 What is the process of Nepal Standard Certification system? In the context of Nepal, give your analytical opinion about its effectiveness and relevancy. (8)