**Syllabus for B.Sc. I, II, III**

**Subject: Industrial Chemistry**

**B.Sc. FirstYear**

**Paper Title of Paper M.M.**

**Paper I - Industrial Aspects of Organic and Inorganic chemistry 50**

**Paper II - Industrial Aspects of Physical chemistry, Material and Energy balances 50**

**Paper III - Unit operations and Utilities in Chemical Industry 50**

**Practical: 50**

**B.Sc. SecondYear**

**Paper I - Material science and Industrial Pollution 50**

**Paper II - Unit Processes in Organic Chemicals Manufacture 50**

**Paper III - Effluent treatment, Waste management and Process instrumentation 50**

**Practical: 50**

**B.Sc. ThirdYear**

**Paper I - Industrial Chemical Analysis 50**

**Paper II - Polymers & Pharmaceuticals 50**

**Paper III – Dyes and Agrochemicals 50**

**Paper IV - Chemical Process Economics and Entrepreneurship 50**

**Practical: 100**

**Note:**

* **The educational tour/visit of students of B.Sc. IIIrd year is compulsory.**
* **Project work is also compulsory at students of B.Sc. IIIrd year.**

**B.Sc. I**

**Industrial Chemistry**

**Paper I**

**M.M.: 50**

**Industrial Aspects of Organic and Inorganic chemistry:**

1. **Nomenclature:** Generic names, trade names
2. **Raw materials for organic compounds:** Petroleum, natural gas, fractionation of crude oil, cracking, reforming, hydro forming and isomerisation.
3. **Coal:** Types of coal, properties, calorific value, distillation of coal, chemicals derived from them.
4. **Renewable Natural resources:** Cellulose, Starch: (Properties, modification, important industrial chemicals derived from them. alcohols, oxalic acid and furfural.
5. **Basic Metallurgical operations:** pulverization, calcinations, roasting, refining of metals.
6. **Physicochemical principles of extraction:** Iron, Copper, Lead, Silver, Sodium, Aluminium and Zinc.
7. **Inorganic Materials of Industrial Importance:** Availability, forms, structure and modifications of – alumina, silicates, clays, mica, carbon, zeolites.

**B.Sc. I**

**Industrial Chemistry**

**Paper II**

**M.M.: 50**

**Industrial Aspects of Physical Chemistry and Material & Energy balances:**

1. **Surface chemistry and Interfacial phenomena:** Adsorption isotherm, sols, gels, emulsions, micro emulsions, micelles, aerosols, effect of surfactants, hydrotropes.
2. **Catalysis:** Introduction, types, basic principles, mechanisms, factors affecting the performance, introduction to phase transfer catalysis, enzymes catalyzed reactions- rate model, industrially important reactions.
3. **Dimensions and Units:** Basic chemical calculations – atomic weight, molecular weight, equivalent weight, mole concept, composition of liquid and gaseous mixtures.
4. **Material Balance without chemical reactions:** Flow diagram for material balance, simple material balance with or without recycle or bypass for chemical engineering operations such as distillation, absorption, crystallization, evaporation, extraction etc.
5. **Material Balance involving chemical reactions:** Concept of limiting reactant, conversion, yield, selectivity, and liquid phase reaction, gas phase reaction with or without recycle or bypass.
6. **Energy Balance:** Heat capacity of pure gases and gaseous mixtures at constant pressures, sensible heat changes in liquids, enthalpy changes.

**B.Sc. I**

**Industrial Chemistry**

**Paper III**

**M.M.: 50**

**Unit operations and Utilities in Chemical Industry:**

1. **Distillation:** Introduction, batch and continuous distillation, separation of azeotropes, plate columns and packed columns.
2. **Absorption:** Introduction, equipments, packed columns, spray columns, bubble columns, mechanically agitated contactors.
3. **Evaporation:** Introduction, equipments, short tube evaporator, forced circulation evaporators, falling film evaporators, wiped (agitated) film evaporators.
4. **Filtration:** Introduction, equipments, plate and frame filter press, Nutch filter, rotary drum filter, sparkler filter, candle filter, Bag filter.
5. **Drying:** Introduction, free moisture, bound moisture, drying curve, equipments - tray dryer, rotary dryer, flash dryer, fluid bed dryer, drum dryer, spray dryer.
6. **Crystallization:** Introduction, Solubility nucleation and supersaturation, Fractional crystallization, Equipments-Tank Crystalliser, Evaporator crystallizer.
7. **Extraction:** Introduction, selection of solvents, Equipments- Spray, Column, packed column, Soxhlet Extractor.
8. **Utilities in Industry:**

Fuel: Types of fuels – advantages and disadvantages.

Boilers: Types of boilers and their functioning.

Water: Specifications for Industrial use, various water treatments.

Steam: Generation and use.

Air: Specifications for industrial use, processing of air.

**B.Sc. I**

**Industrial Chemistry**

**Practical**

**M.M.: 50**

**Time: 6 Hour**

1. **Preparation of standard solution of K2Cr2O7. To find out the concentration of unknown K2Cr2O7 solution usingNa2S2O3 solution as an intermediate.**
2. **Preparation of standard solution of copper sulphate. To find out the concentration of unknown copper sulphatesolution using Na2S2O3 solution as an intermediate.**
3. **Preparation of standardKMnO4 and ferrous ammonium sulphate solution. To find out the strength of unknown ferrous ammonium sulphate solution using as an intermediate.**
4. **Viscosity of liquids:**

* **Determination of relative viscosity of a liquid with water.**
* **Determination of % composition of an unknown solution.**

1. **Surface Tension of liquids:**

* **Determination of the surface tension of an organic liquid.**
* **Determination of % composition of an unknown mixture.**

1. **Polari-meter:**

* **Determination of the specific rotation of sucrose solution.**

1. **Refractometer:**

* **Determination of Refractive Index of a liquid by Abbe’s refractometer.**
* **Determination of Molar refractivity and specific refractivity of a liquid by using Abbe’s refractometer.**

1. **To find out the melting points of organic compounds.**
2. **To find out the boiling points of organic compounds.**
3. **To find out the partition coefficient of:**

* **Iodine between CCl4 and water**
* **Acetic acid between water and benzene.**

1. **Chromatography:**

* **To separate and identify the amino acids by ascending paper chromatography.**
* **To separate and identify the sugars by ascending paper chromatography.**

1. **Separation of a mixture of dyes by column chromatography.**

**B.Sc. II**

**Industrial Chemistry**

**Paper I**

**M.M.: 50**

**Industrial Pollution, Effluent treatment & Waste management:**

1. **Biosphere:** Introduction, Nitrogen cycle.
2. Principles and equipments for aerobic, anaerobic treatment, adsorption, filtration, sedimentation.

Bag filters, Electrostatic precipitator, Mist eliminator, Wet scrubbers, Absorbers.

1. **Solid waste management,** Industrial safety, Pollution control in industries, Biomedical waste management.
2. **Industrial Pollution:**

**Pollutants:** Their statutory limits, pollution evaluation methods.

**Air pollution:** Photochemical smog, PAN,

**Water pollution:** Organic/inorganic pollutants, sewage analysis, BOD, COD, Eutrophication,

T.D.S., Carl-Fischer Reagent.

**Miscellaneous Pollution:** Noise pollution, Pesticide pollution, Nuclear Radiation pollution and Green House Effect.

**B.Sc. II**

**Industrial Chemistry**

**Paper II**

**M.M.: 50**

**Unit Processes in Organic Chemicals Manufacture:**

1. **Nitration:** Introduction, nitrating agents, mechanism and nitration of paraffin hydrocarbons - benzene to nitrobenzene, m-dinitrobenzene, chlorobenzene to o & p-nitrochlorobenzenes. Acetanilide to p-nitro acetanilide, toluene, continuous Vs batch nitration.
2. **Halogenation:** Introduction, reagents for halogenations, halogenations of aromatics – side chain and nuclear halogenations, commercial manufacture of chlorobenzene, chloral, monochloroacetic acid and chloromethanes.
3. **Sulphonation:** Introduction, sulphonating agents, chemical and physical factors in sulphonation, mechanism of sulphonation, commercial sulphonation of benzene, naphthalene, alkyl benzene, batch Vs continuous sulphonation.
4. **Oxidation:** Introduction, types of oxidation reactions, oxidizing agents, mechanism of oxidation, liquid phase oxidation and vapour phase oxidation, commercial manufacture of benzoic acid, maleic anhydride, phthalic anhydride, acetaldehyde, acetic acid.
5. **Hydrogenation:** Introduction, catalysts for hydrogenation reactions, hydrogenation of vegetable oil, manufacture of methanol from carbon monoxide and hydrogen, catalytic reforming.
6. **Alkylation:** Introduction, types of alkylation, alkylating agents, mechanism of alkylation reactions, manufacture of phenyl ethyl alcohol and ethyl benzene.
7. **Sugar:** Manufacturing process of sugar from sugarcane and sugar beets.

**B.Sc. II**

**Industrial Chemistry**

**Paper III**

**M.M.: 50**

**Process Instrumentation and Material Science:**

1. **Principles, construction and working of following measuring instruments:**

* **pH** meter, conductivity meter.
* **Temperature –** Glass thermometers, bimetallic thermometer, pressure spring thermometer, vapour filled thermometer, resistance thermometers, and radiation pyrometers.
* **Pressure –** Manometers, barometers, bourdon pressure gauge, bellow type, diaphragm type pressure gauge, Macleod gauges, pirani gauges etc.
* **Viscosity and Density** measurement.

1. **Material Science:**

* **Mechanical properties** of materials and change with respect to temperature.
* **Metals and alloys:** Important metals and alloys, Iron, Copper, Aluminium, Lead, Nickel, Titanium and their alloys – mechanical and chemical properties and their applications.
* **Cement:** Types of cement, composition, manufacturing process, setting of cement.
* **Ceramics:** Introduction, types, manufacturing processes, applicat ions, refractory.
* **Glass:** Types, composition, manufacture, physical and chemical properties, applications.
* **Corrosion:** Various types of corrosion relevant to chemical industry - mechanism, preventive methods.

**B.Sc. II**

**Industrial Chemistry**

**Practical**

**M.M.: 50**

**Time: 6 Hour**

**Practical:**

1. Determination of calorific value of solid fuels.
2. Analysis of carbohydrates.
3. **Water Analysis**– Solid content, hardness, COD and other tests as per industrial specifications.
4. Separation of organic and inorganic mixture by TLC.
5. Instrumental methods of analysis – pH meter and conductivity meter.
6. **Unit process** – one or two examples of each of the following unit processes.

Nitration, sulphonation, friedel crafts reaction, esterification, hydrolysis, oxidation, halogenations, chlorosulphonation, reduction and polymerization.

1. Limit tests for heavy metals – Pb, As, Hg, Fe and ash content.

**B.Sc. III**

**Industrial Chemistry**

**Paper I**

**Industrial Chemical Analysis**

**M.M.: 50**

**Industrial Chemical Analysis:**

1. **Sampling** procedures, sampling of bulk materials, techniques of sampling – solids, liquids and gases. Collection and processing of data.
2. **Chromatography:** Principles, working and applications of – paper chromatography, TLC, GLC, HPLC.
3. Particle size determination, rheological properties of liquids, plastics and their analysis.
4. **Modern Instrumental Methods of analysis (Basic Concepts and Instrumentations of followings ):**

UV-visible spectroscopy

IR spectroscopy and non-dispersive IR

Raman spectroscopy,

NMR Spectroscopy,

Electron spin resonance spectroscopy

Atomic absorption spectroscopy

Flame photometry

Neutron diffraction

X-ray fluorescence

Ion chromatography

**B.Sc. III**

**Industrial Chemistry**

**Paper II**

**Polymers & Phramaceuticals**

**M.M.: 50**

**Polymers:**

1. Brief history of macromolecular science, Types of polymers - functionality concept, necessity of copolymers and copolymerization, block and graft copolymers. Conducting Polymers.
2. **Types of polymerizations** – Addition, condensation, mechanism of polymerization – free radical, ionic (anionic and cationic), co-ordination polymerization, initiators, inhibitors.
3. **Molecular weight distribution** – Number, weight and viscosity average molecular weights of polymers, methods of determining molecular weights.
4. **Synthesis, chemistry, properties and applications of the following Thermosetting polymers:-**

Polycarbonates, Epoxy resins – grades and curing process, Silicones.

1. **Synthesis, chemistry, properties and applications of the following Thermoplastics polymers:-**

Polyvinyl chloride, Teflon, SBR, PVA, nylon-66, terephthalates.

**Pharmaceticals:**

* 1. Historical background and development of pharmaceutical industry in India. Introduction to pharmacopoeias. Types of formulations and roots of administration. Aseptic conditions, need for sterilization, Method of sterilization.
  2. **Evaluation of crude drugs** – moisture contents, extractive value, volatile oil content, foreign organic matter. Quantitative microscopic exercises including of starch, crude fiber content.
  3. **Pharmaceutical Quality Control** – sterility testing, pyrogenic testing, glass testing, bulk density of powders etc.
  4. **Raw materials, process of manufacture of the following bulk drugs:**

Sulphaguanidine, chlorampinecol, ibuprofen, mefenamic acid, chloropheneramine maleate, chloroquin.

**B.Sc. III**

**Industrial Chemistry**

**Paper III**

**Dyes and Agrochemicals**

**M.M.: 50**

**Dyes:**

1. Introduction to the history of dyes, Classification, Natural and Synthetic dyes. Colour and Chemical constitution of dyes.
2. **Analysis of Dyes and Dye intermediates:** Different methods used in the analysis, nitrite value, halogen content determination, Metal estimations- Cu, Ni, Cr.
3. **Dyeing methods:** General introduction, dyeing methods for the following dyes- Direct, Acid, Vat, Cationic, Indigo.
4. **Synthesis and uses of Following Dyes:** Bismark Brown, Rosaniline, Eosin, Indigo, Methylene Blue, Direct-S.

**Agrochemicals:**

1. **Introduction,** Pests, Pest Controls, types of pesticides-Stomach poisons, contact poisons, systemic poisons, fumigants.
2. **Insecticides (preparation and uses):**

* **Inorganic Insecticides:** Arsenic insecticides, Paris Green
* **Insecticides of plant origin:** Nicotine, pyretrhoids, allethrins, rotenoids.
* **Organophosphorus Insecticides:** Malathion, Mecarbam.
* **Chlorinated Insecticides:** BHC, Dialdrin, Endosulfan

1. **Fungicides:** Introduction, Bordeuax mixture, Burgundy mixture, Polpet, Mesulfan.
2. **Herbicides:** Introduction, 2,4-D, MCPB
3. **Rodenticides:** Zink Phosphide, Warfarin.

**B.Sc. III**

**Industrial Chemistry**

**Paper IV**

**Chemical Process Economics and Entrepreneurship**

**M.M.: 50**

**Chemical Process Economics and Entrepreneurship:**

1. **Marketing-** Meaning of market & marketing distinction, classification of market, Classification of goods, concept of market.
2. **Depreciation-** methods of determining depreciation. Some aspects of marketing, pricing policy, profitability criteria, economics of selecting alternatives, variation of cost with capacity, break-even point, optimum batch sizes, production scheduling etc.
3. **Planning-** Nature of planning and decision making, Significance of planning.
4. **Choice of Technology-** plant and equipments. Techno-economic feasibility of the projects. Plant layout and process planning for the project.
5. **Channels of distribution –** Meaning of channels of distribution-
6. Manufacturer consumer channels.
7. Manufacturer retailer ultimate consumer.
8. Manufacturer agent whole seller retailer.
9. **Resources management-** men, machine and materials. Creativity and Innovations. Problem solving approach. Strength, weakness, opportunity and threat (SWOT) techniques.
10. Quality control, quality assurance and testing of the product. Packaging and advertising. After sales service.
11. Sickness in small scale Industries and their remedial measures. Licensing and registration. Important provisions of Factory Act, sales of goods Act, partnership Act.

**B.Sc. III**

**Industrial Chemistry**

**Practical**

**M.M.: 100**

**Time: 6 Hour**

1. Preparation:

* Dye: Eosin, Fluorescene
* Drugs: Paracetamol, Aspirin, Urotropine, Oil of Wintergreen.
* Fragrance: Oil of Nerol.
* Soap: Simple soap.

1. Extraction:

* Caseine from milk
* Citral from lemon grass.
* Caffeine from tea leaves

1. Estimation:

* Estimation of sulphur in organic compounds (Messenger method).
* Estimation of hydroxyl group in glucose.

1. Analysis:

* Percentage of Zn and copper in brass sample.
* BOD of water sample.
* Acid Value, Iodine Value and saponification value of given fat or oil.
* Gravimetric analysis of Ba as BaSO4.

1. Identification:

* Identification of drugs by TLC.
* Identification of amino acids by TLC.

1. Purification:

* Decolourisation of impure sample by charcoal treatment.

1. Instrumental methods of analysis – colorimeter, flame photometer.