SYLLABUS
&
Scheme of Examination
B.Sc. Industrial Chemistry
First year

First Semester

Theory	Max. Marks Written + I.A.	Time allowed for Exam (Hours)
Paper – I	40+10	3 hrs
Paper – **II**	40+10	3 hrs

Second Semester

Theory	Max. Marks Written + I.A.	Time allowed for Exam (Hours)
Paper –I	40+10	3 hrs
Paper – II	40+10	3 hrs

Practical

Paper - **III**	100 (No internal Assessment Marks in Practical)	7 hrs *(Spread over two days in two sessions)*

Second Year.

Third Semester

Theory	Max. Marks Written + I.A (Internal Assesment)	Time Allowed for Exam
Paper-I	40+10	3 Hours
Paper-II	40+10	3 Hours

Fourth Semester

Theory	Max. Marks	Time Allowed for Exam

	Written + I.A. (Internal Assessment)	
Paper-I	40+10	3 Hours
Paper-II	40+10	3Hours

Practical

Paper-III	100 (No internal Assessment Marks in Practical)	7 hrs *(Spread over two days in two sessions)*

Third Year

Fifth Semester

Theory	**Max. Marks Written + I.A.**	**Time allowed for Exam**
Paper-I	40+10	**3 Hours**
Paper-II	40+10	**3 Hours**

Sixth Semester

Theory	**Max. Marks Written + I.A.**	**Time allowed for Exam**
Paper-I	40+10	**3 Hours**
Paper-II	40+10	**3 Hours**

Practical

Paper-III	100 (No internal Assessment Marks in Practical)	7 hrs *(Spread over two days in two sessions)*

First Semester

Paper – I (Theory) Max. Marks: 40+10* 3 hours

Note: Eight questions will be set section wise, two questions from each section and the candidate have to attempt five questions in all selecting at least one questions from each section. All questions carry equal marks.

Section – I

Metallurgy: Basic metallurgical operations- crushing and pulverization, concentration, calcinations, roasting, reduction and refining.

(7½)

Section – II

Physico chemical principles of extraction, methods of extraction and refining of copper, lead, aluminum and zinc from their important ores.

(7½)

Section – III

Surface Chemistry: Preparation, types and applications of emulsions, sols, gels, micelles and aerosols.

(7½)

Section – IV

Catalysis: Introduction, characteristics of catalytic reactions, homogeneous and heterogeneous catalysis and their theories, catalytic poisoning, auto-catalysis, introduction to enzyme catalysis and kinetic expression– Michael-Menton equation, characteristics of enzyme catalysis.

(7½)

First Semester

Paper – II (Theory) **Max. Marks: 40+10*** **3 hours**

Note: Eight questions will be set section wise, two questions from each section and the candidate have to attempt five questions in all selecting at least one questions from each section. All questions carry equal marks.

Section – I

1. Crystallization: Introduction, concept of super saturation, modes of generation of super saturation, nucleation, primary nucleation and secondary nucleation, crystal growth, ΔL Law of crystal growth; equipment – circulating liquid evaporator crystallizers.

(4)

2. Evaporation: Introduction, factors affecting the rate of evaporation and choice of evaporators, application of evaporation in chemical process industries, equipment- falling film evaporator.

(3½)

Section – II

1. Drying: Introduction, free moisture, bound moisture, equilibrium moisture content, drying rate and drying curves, constant rate period and falling rate period of drying, purpose of drying, equipments -rotary dryers.

(4)

2. Distillation: Introduction, types of distillation - simple batch or differential distillation, simple steam distillation, and continuous distillation with reflux/fractional distillation.

(3½)

Section – III

1. Filtration: Introduction, filter media and filter aids, qualities/ characteristics of ideal filter aids, factors affecting the rate of filtration and choice of filter media, equipments- candle filters.

(6)

2. Absorption: Introduction, desorption or gas stripping, equipments- spray columns for absorption.

(1½)

Section – IV

1. Material balance: Introduction, material balance without chemical reactions, general methods of solving material balance problems for systems involving no chemical reactions, a brief study of procedure for material balance calculations, flow/block diagrams for various important chemical engineering operations such as – **distillation, absorption and crystallization** and their overall material balance equations (***Numericals excluded***).

(6½)

2. Bypass operations along with block diagrams (***Numericals excluded***) and their importance in process industries.

(1)

Second Semester

Paper – I (Theory) **Max. Marks: 40+10*** **3 hours**

Note: Eight questions will be set section wise, two questions from each section and the candidate have to attempt five questions in all selecting at least one questions from each section. All questions carry equal marks.

Section – I

Nomenclature, generic names and trade names. (3)

Fuels and Combustion: Classification of fuels, comparison between solid, liquid and gaseous fuels, calorific value and characteristics of good fuel.

(4½)

Section – II

Coal: Types of coal, analysis of coal- proximate and ultimate analysis with its significance, determination of calorific value by bomb calorimeter.

(7½)

Section – III

Petroleum– fractional distillation of crude oil, cracking- thermal and catalytic cracking, isomerisation. (7½)

Section – IV

Corrosion: Definition, types of corrosion, dry or chemical corrosion, wet or electrochemical corrosion, concentration cell corrosion, stress corrosion, soil corrosion, microbiological corrosion, their theories and mechanism, passivity, factors influencing corrosion, methods of corrosion control.

(7½).

Second Semester

Paper – II (Theory) **Max. Marks: 40+10*** **3 hours**

Note: Eight questions will be set section wise, two questions from each section and the candidate have to attempt five questions in all selecting at least one questions from each section. All questions carry equal marks.

Section – I

1. Material balance involving chemical reactions: Introduction, brief study of terms involved- stoichiometric equation, stoichiometric coefficients, concept of limiting reactant, excess reactant and conversion, recycling operations, need for their adoption in process industries.

(5)

2. Air: Introduction of air pollution, classification of air pollutants, processing of air by cyclone separators.

(2½)

Section – II

1. Energy balance: Introduction, law of conservation of energy, outline of general procedure for making energy balance calculations, enthalpy changes accompanying a chemical reaction, Hess's law of constant heat summation, heat capacity, heat capacity of pure gases at constant pressure and constant volume, relation between C_P and C_V.

(4½)

2. Fluids flow: Introduction, concept of compressible and incompressible fluids, a brief study of nature of fluid flow– streamline or laminar flow, turbulent flow, Reynolds number, and its applications.

(3)

Section – III

1. Water: Water specifications for different industries, hardness of water, types of hardness, water softening by Permutit process using ion exchange resins and regeneration of ion exchange resins.

(6)

2. Boilers: Introduction, classification of boilers, uses of boilers.

(1½)

Section – IV

1. Heat transfer: Introduction, mechanism of heat transfer, Fourier's law of heat conduction, equipments: brief study of finned tube heat exchangers, corrugation, types of corrugation and air cooled heat exchanger.

(6)

2. Steam: Basic specification of water used for steam production, various applications of steam.

(1½)

Second Semester

Paper – III (Practical) **Max. Marks. 100** **7 hours**

Note: In the first session of practical examination, the students are required to perform two experiment out of section–I, whereas, on the second day, they will perform one experiment from section-II.

Section – I

1. Determine volumetrically the percentage purity of a sample of Lunar caustic.
2. Preparation and standardization of sodium hydroxide solution.
3. Determination of calcium and magnesium in a sample of hard water.
4. To determine total hardness of given water sample.
5. To determine the percentage of copper in given sample of brass alloy.
6. To analyse the given sample of calcite ore.
7. To analyse the amount of calcium present in a given sample of limestone.
8. Prepare and standardize the given sample of $KMnO_4$.

Section –II

1. Determine the specific and molecular rotation of an optically active substance like cane sugar at a number of concentrations.
2. Determine the concentration of a given solution of an optically active substance by polarimetric measurement.
3. Determine the refractive index of a given liquid by Abbe's refractrometer and find the specific and molar refraction.
4. Determine the molar refractivity of methyl acetate, ethyl acetate, *n*–hexane and carbon tetrachloride and calculate the refraction equivalents of carbon, hydrogen and chlorine.

5. To determine the coefficient of viscosity of a given liquid with the help of Ostwald's viscometer.
6. To determine the surface tension of the given liquid by drop-number method.
7. To determine the surface tension of the given liquid by drop-weight method.
8. To determine the surface tension of given liquid in the presence of surfactant.

Distribution of Marks

Experiment No.1 (From Section – I)	30 Marks
Experiment No.2 (From Section – I)	15 Marks
Experiment No.3 (From Section – II)	30 Marks
Lab Record	15 Marks
Viva-voce	10 Marks

Books Recommended for Ist paper (Semester I & II):

1. Study Material in Vocational Subject to Industrial Chemistry (B.Sc. I, UGC) Sponsored.
2. Physical Chemistry by B. R. Puri, L. R. Sharma & M. S. Pathania.
3. Principles of Extractive Metallurgy, Herbashi Vol. 1 & 2

Books Recommended for IInd paper (Semester I & II):

1. Study Material in Vocational Subject of Industrial Chemistry (B.Sc. I, UGC Sponsored) (**Text Book)**
2. Introduction to Chemical Engineering W. L. Badger and J. T. Banchero, McGraw-Hill Book Co., USA.
3. Unit Operations in Chemical Engineering W. L. McCabe and J. C. Smith, McGraw-Hill Books co., New York.

Third Semester

Paper-I (Theory) Max. Marks 40+10* 3 Hours

Note: Nine questions will be set section wise, three from each section and candidate have to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Section-I

Pulp and paper industry:

Introduction, Manufacture pulp, sulphate or Kraft pulp, soda pulp, sulphite pulp, rag pulp, beating refining, filling, sizing and coloring. Manufacture of paper, calendaring, uses. Paper industry in India

Sugar Industry:

Introduction, Manufacture of cane sugar, extraction of juice, purification of juice, defection, sulphonation and carbonation, concentration and evaporation, Crystallisation. Recovery of sugar from molasses. Manufacture of sucrose from beet root. Testing of sulphur.

Section-II

Cement Industry:

Types of cement, composition, manufacturing process of Portland cement (dry & wet processes). Setting of cement, properties of cement. Testing of cement.

Refractories:

Types, Properties, Manufacture and application of various refractories.

Ceramics:

Introduction, types, manufacturing process of white wares and earthen wares. Applications

Section-III

Nitration:

Introduction, nitrating agents, kinetics and mechanism of nitration of benzene.

Manufacture of the following

I. Nitrobenzene and m-Dinitrobenzene from Benzene.
II. p-Nitroacetanilide from acetanilide

Continuous Vs Batch Nitration

Halogenation:

Introduction, kinetics of halogenation reactions. Reagents for halogenation. Halogenation of aromatics-side chain and Nuclear Halogenation. Commercial Manufacture of chlorobanezene, Chloral, dichlorofluromethane.

Third Semester

Paper-II (Theory) Max. Marks 40+10* 3 Hours

Note: Nine questions will be set section wise, three from each section and candidate have to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Section-I

Air pollution:
Air pollutants such as sulphur di oxide, sulphur tri oxide, oxides of nitrogen, carbon mono oxide. Particulate matter i.e. dust, smoke, smog and aerosols, their sources and bad effects.
Deforestation and its consequences, Green house effect and its consequences.
Remedial measures to control air pollution

Section-II

Noise Pollution:
Definition, noise level i.e. bearable limit, sources of noise pollution, bad effects and prevention of noise pollution

Pesticide Pollution:
Classification of pesticides, sources of pesticide pollution, bad effects and control measure.

Water Pollution:
Sources of water pollution, Bad effects and control of water pollution.

Section-III

Water analysis:

Determination of alkalinity
Determination of acidity
Determination of hardness
Determination of dissolved oxygen
Determination of chloride content
Determination of nitrates
Determination of Sulphates
Determination of Phosphates

Fourth Semester

Paper-I (Theory) Max. Marks 40+10* 3 Hours

Note: Nine questions will be set section wise, three from each section and candidate have to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Section-I

Sulphonation:
Introduction, sulphonating agents, mechanism of sulphonation reactions, Commercial sulphonation of benzene, alkyl benzenes.

Oxidation:
Introduction, types of oxidation reactions, oxidizing agents, commercial manufacture of benzoic acid, phthalic anhydride, acetaldehyde, acetic acid.

Section-II

Hydrogenation:
Introduction, catalysts for hydrogenation, organic chemical Manufacture-II Reaction, Hydrogenation of vegetable oils manufacture of methanol from certain Monoxide and Hydrogen.

Alkylation:
Introduction, types of alkylation, alkylating agents, Thermodynamics and mechanism of alkylation Reactions, manufacture of Alkyl Benzenes (for detergent Manufacture), Ethyl Benzenes.

Section-III

Esterification:
Introduction, hydrodynamics and kinetics of esterisfication reactions, esterification by organic acids, by addition of unsaturated compounds, commercial manufacture of ethyl acetate.

Amination:
Introduction, Methods of reductionmetal and acid catalytic, sulphite, electrolytic metal and alkali sulphites, metal hydrides, sodium metal, concentrated caustic oxidation, reduction commercial manufacture of
aniline.

Hydrolysis:
Introduction, hydrolyzing agents, kinetics, thermodynamics and mechanism of hydrolysis.

Fourth Semester

Paper-II (Theory) Max. Marks 40+10* 3 Hours

Note: Nine questions will be set section wise, three from each section and candidate have to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

Section-I

Treatment of Domestic waste water:
Preliminary treatment i.e. removal of gross solid, grit, oil and grease. Primary treatment i.e. sedimentation.
Secondary treatment i.e. trickling filters
Tertiary treatment i.e. precipitation, nitrogen stripping and chlorination.
Treatment of petroleum refinery waste.

Section-II

Solid Waste Management
Classification of solid waste,
Microbiology of solid waste,
Disposal processes i.e. composting,
Sanitary land filling,
Incineration and pyrolysis.

Section-III
Process Instrumentation:
Principle, Construction and working of the following instruments
Glass thermometer,
Bimetallic thermometer,
Resistence thermometer,
Radiation Pyrometers.
Pressure-manometers,
Barometers,

Fourth Semester

Paper-III (Practical) Max. marks 100 7 Hours

Note: The practical is spread over in two sessions. In the first session the candidate have to perform one experiment from first section and in the second session the candidate have to perform one experiment from the second section.

Section-I

Nitration
Preparation of m-dinitro benzene

Sulphonation
Preparation of Sulphanilic acid

Reaction of diazonium salt
Preparation of 1-phenyl azo β-naphthol

Oxidation
Prepare anthraquinone from anthracene.
Prepare p-nitro benzoic acid from p-nitro aniline.

Reduction
Preparation of m-nitro aniline from m-dinitro benzene.

Section-II

Water Analysis
Determination of alkalinity of water sample.
Determination of acidity of water sample.

Determination of total hardness of water sample.

Determination of temporary and permanent hardness of water sample.
Determination of dissolved oxygen of water sample.

Determine pH of given water sample.
Determine percentage of iron in given sample of mohr's salt.

Distribution of Marks

Experiment No. 1 (from section-I)	40 Marks
Experiment No. 2 (from section-II)	35 Marks.
Lab Record	15 Marks
Viva Voce	10 Marks

Books Recommended for third and fourth semesters:

1. Study material in Vocational subject of industrial chemistry (BSc-II UGC Sponsored)
2. Science of ceramics-chemical processing: Hench L.L
3. Pollution control of chemical and Allied Industries Mahajan, S.P.

Fifth Semester

Paper –I Theory Max Marks 40+10 3 Hours

Note: Nine Question will be set section wise, three from each section and candidate have to attempt five question in all selecting at least one question from each section. All questions carry equal marks.

Section-I

Industrial Chemical Analysis

Sampling procedure, sampling 0f bulk materials, techniques of sampling solids, liquids and gases. Collecting and processing data.

Limitations of analytical methods, accuracy, precision, classification of errors and their minimization. Significant figures and computations.

(10 Hours)

Section –II

Chromatography

Principle and classification of chromatographic method, paper chromatography, Thin layer chromatography, HPLC and gas chromatography.

(10 Hours)

Section-III

Atomic Spectroscopy

Principle, types of instruments, interferences in flame photometry, application of atomic absorption and flame emission spectroscopy.

Spectrophotometer

Principle, instrumentation for absorption measurements, qualitative and quantitative applications.

Nephelometry

Principle instrumentation, factors affecting measurements, applications.

(10 Hours)

Books Recommended

1. Vogel's Text book of Quatitative Chemical Analysis, G.H. Jeffery, J. Basset, J. Mendham and R.C.Denney, English Language Book Society/ Longman
2. Study Material in vocational subject, Industrial Chemistry (UGC Sponsored)
3. Handbook of instrumental techniques for Analytical chemistry, F.A. Settle, Prentice Hall.
4. Quantitative Inorganic Analysis, K. Kodama Interscience Publishers, New York.

Fifth Semester

Paper –II Theory Max Marks 40+10 3 Hours

Note: Nine Question will be set section wise, three from each section and candidate have to attempt five question in all selecting at least one question from each section. All questions carry equal marks.

Section-I

Introduction to Pharmacopoeias

Dosage Forms: Dosage forms and their classification on the basis of physical state with important characteristics: Solid Dosage forms including powders, capsules, cachets, Pills, tablets and suppositories.

Liquid dosage forms including collodions, aromatic waters, inhalations, injections, lotions, mouth washes, nasal drops and ophthalmic drops.

Sterilization: Need for sterilization, sterilization by heat processes viz sterilization by dry heat using hot air oven, flaming and I.R. radiations. Moist heat sterilization processes including autoclaving, heating with bactericide, Tantalization or fractional sterilization.

(10 Hours)

Section- II

Legal aspects of drugs: Important FDA Schedules

(2 Hours)

Pharmaceutical quality testing: Sterility testing, Pyrogen testing, glass testing.

(4 Hours)

Pharmaceutical excipients : Various type of excipients used for tablets, capsules, emulsions and suspensions.

(4 Hours)

Section-III

Phytochemicals: Introduction to crude drugs, cultivation and storage of medicinal plants.

(4 Hours)

Chemical constituents of plants and uses including carbohydrates, glycosides, fats, oils, waxes, terpenoids, steroids, alkaloids, amino acids, and tannins.

(6Hours)

Books Recommended

1. A text book of pharmaceutics- Nirali Prakashan.
2. Study Material in vocational subject, Industrial Chemistry (UGC Sponsored)

Sixth Semester

Paper –I Theory Max Marks 40+10 3 Hours

Note: Nine Question will be set section wise, three from each section and candidate have to attempt five question in all selecting at least one question from each section. All questions carry equal marks.

Section-I

Solvent Extraction : General discussion, factors favoring solvent extraction, classification of solvent extraction systems, applications of solvent extraction.

(7 Hours)

pH, buffer solutions, importance of pH and its measurement.

(3 Hours)

Section-II

Monograph of tablet: Hardness test, Friability test, Dissolution rate, and disintegration test.

(4 Hours)

Amperometric titration: Theory, types and applications of amperometric titration.

(3 Hours)

Polarimetry: Principle, instrumentation and applications of polarimetry.

(3Hours)

Section-III

Titrimetric Analysis: Theoretical considerations, standard solutions, primary standards, Secondary standards, neutralization indicators, mixed indicators, universal indicators, neutralization curves, choice of indicator in neutralization reactions, complexation titrations, metal ion indicators, precipitation titrations.

(10 Hours)

Books Recommended

1. Vogel's Text book of Quatitative Chemical Analysis, G.H. Jeffery, J. Basset, J. Mendham and R.C.Denney, English Language Book Society/ Longman
2. Study Material in vocational subject, Industrial Chemistry (UGC Sponsored)
3. Indian pharmacopoeia/ British pharmacopoeia

Sixth Semester

Paper –II Theory Max Marks 40+10 3 Hours

Note: Nine Question will be set section wise, three from each section and candidate have to attempt five question in all selecting at least one question from each section. All questions carry equal marks.

Section-I

Drugs: classification of various types with examples: analgesics, cardiovascular agents, anti psychoactive agents

(5 Hours)

Synthesis of bulk drugs
Antimicrobial- Chloromphenicol, Isoniazid
Analgesic- Salicylic acids and its derivatives, Ibuprofen
Barbiturate- Pentobarbitol
Blockers- Propranprol, Atenolol

(5 hours)

Section-II

Fermentation Processes: General principle of fermentation processes and fermenters

(2Hours)

Manufacturing of anti biotics: Penicillin G, Vitamin B_{12} tetracyclines.

(5 Hours)

Synthesis of vitamins: vitamin-A, Vitamin-B_6 , Vitamin- C

(3 Hours)

Section-III

Pharmaceutical excipients: Various Types
Capsule shell making agent (gelatin)
Binder and adhesives (acacia)
Antioxidant (Butylated hydroxy anisole)
Viscosity builder (carboxy methyl cellulose sodium)
Preservatives (Phenyl mercuric nitrate)
Sweetners (Mannitol)
Emulsifying agents and coating agents

(10 Hours)

Books Recommended

1. Medicinal chemistry : Ashutoshkar (Vol. I & II)
2. Medicinal chemistry : S.N. Pandeya
3. Study Material in vocational subject, Industrial Chemistry (UGC Sponsored)

Sixth Semester

Paper-III Practical Max Marks 100 7 Hours

Note: The practical is spread over in two sessions. In the first session the candidate have to perform two experiments from section-I, (one from the first four and second from the next seven). In the second session the candidate have to perform one experiment from section-II.

Section-I

1. To prepare a sample of 2,4,6 tribromo aniline
2. To prepare a sample of anthranilic acid from phthalic anhydride
3. To prepare a sample of m-dinitrobenzene from benzene
4. To prepare m-nitroaniline from nitrobenzene
5. To prepare a sample of chloroform spirit
6. To prepare a sample of benzaldehyde spirit
7. To prepare a sample of chloroform water
8. To prepare a sample of camphor water
9. To prepare a sample of cetrimide cream
10. To prepare a sample of zinc sulphate lotion
11. To perform the monograph of aspirin tablet

Section-II

1. To estimate the percentage purity of given amino acid
2. Estimate the amount of aspirin in the given tablet
3. To determine the strength of given phenol solution by bromination method
4. To determine the strength of given aniline solution by bromination method
5. To determine the percentage purity of given sample of formaldehyde
6. To determine the iodine value of given oil sample
7. To determine the saponification value of oil sample

Distribution of marks

Experiment No. 1 (from section-I)	**25 Marks**
Experiment No. 2 (from section-I)	**25 Marks**
Experiment No. 3 (from section-II)	**25 Marks**
Lab Record	**15 Marks**
Viva Voce	**10 Marks**