SHIVAJI UNIVERSITY, KOLHAPUR

★★★★★ B+
Accredited by NAAC

Accredited By NAAC
Syllabus for
Master of Science in Industrial
Chemistry
(Part I/II)

(Subject to the modifications to be made from time to time)

Syllabus to be implemented from June 2011 on wards.

June: 2011

SHIVAJI UNIVERSITY, KOLHAPUR
DEPARTMENT OF INDUSTRIAL CHEMISTRY

M.Sc. COURSE IN “INDUSTRIAL CHEMISTRY"

The Indian Chemical Industries occupies a unique position in the Indian economy in terms of its contribution to employment and export potential. In spite of a strong natural resource base India's share in the global market is meager one. The experts in Industrial Chemistry have emphasized the need for capital infusion capacity, modernisation and upgradation in various segments of industrial processes to bring about efficiencies and economies of scale in order to achieve in global markets. Keeping in view the need of Indian industries, Shivaji University has started M.Sc. course in Industrial Chemistry from academic year 1993-1994 in the Chemistry Department to educate and train the science graduates in industrial chemistry to serve the industrial sector as a technical personnel, R & D personnel, quality control production personnel to manage the industrial production and contribute to the development of nation.

One of the objectives of the M.Sc. Industrial Chemistry Course is to attain new heights in industrial teaching and research, to provide trained man power to vast developing Indian industries to develop the young graduate as a premier precision tool for future creation.

M.Sc. course in industrial chemistry is a potential base provided by the Shivaji University on the University campus to educate the students from rural area who will get employment on large scale in Indian Chemical industries. Since last twelve years, M.Sc. industrial chemistry students have obtained employment on large scale in Indian chemical industries.

Title of the Course: M.Sc. Industrial Chemistry.

Eligibility of Course: Admission to the M.Sc. Industrial Chemistry course will be open to candidates passing B.Sc degree of Shivaji University or any other statutory university in India or abroad with minimum 55% marks and Chemistry as a principal subject of study.

Selection Procedure: Selection will be based on common entrance test of Chemistry Department and personal interview. Maximum '30' candidates will be admitted to M.Sc. Industrial Chemistry.

Fees for the Course: For the detailed fee structure, please see our web site – unishivaji.ac.in

Strength of the students: 27 (13 reserve + 14 open)
03 (other university)
---
30 Total

Duration of the Course: The duration of the M.Sc. Industrial Chemistry course is – two years consisting of '4' semester, each semester spanning for 6' months of minimum 120 working days.

Period of the course from June to November and December to April

Teaching facilities:

1. One-Co-ordinator, two- lecturers, one – teaching assistance.
2. Inter and intra faculty, contributory staff, professors, readers, lecturers, M.Tech., B.Tech. Industrial personnel etc. qualification of the teacher for M.Sc. Industrial Chemistry will be M.Sc., M.Sc., Ph.D., M.Tech., B.Tech. etc.

Scheme of Examination / Assessment with scheme of standard of passing.

The structure of M.Sc. Industrial Chemistry consists of –

1) Theory course
2) Practical course
3) Seminars
4) Industrial training.

Each semester will have theory examination of four papers of 100 marks each (80 marks university examination + 20 marks internal.)

Each Semester will have two practical courses of 100 marks each (80 marks Experimental work + 20 marks Seminars on experimental work).

Semester-IV will have two practical courses out of which one practical course will have 50 marks project work completed in the industries.

Semester-I

Paper No. IC-I : Introduction to Chemical Engineering-I
Paper No. IC-II : General Chemical Technology-I
Paper No. IC -III : Selected Topics in Organic Chemistry
Paper No. IC -IV : Industrial Management
Practical-I
Practical-II

Semester-II

Paper No. IC-V : Introduction to Chemical Engineering-II
Paper No. IC-VI : General Chemical Technology-II
Paper No. IC-VII : Selected Topics in Inorganic Chemistry
Paper No. IC-VIII : Instrumental Methods of Analysis
Practical-III
Practical-IV

Semester-III

Paper No. IC-IX : Organic Chemical Industries-I
Paper No. IC-X : Inorganic Chemical Industries-I
Paper No. IC-XI : Methods of Analysis in Industries
Paper No. IC-XII(A): Pollution Monitoring and Control-I
Paper No. IC-XII(B): Advanced Analytical Techniques in Industries
Paper No. IC-XII(C): Chemical Analysis in Agro, Food and Pharmaceutical Industries.
Practical-V
Practical-VI

Semester-IV

Paper No. IC-XIII : Organic Chemical Industries-II
Paper No. IC-XIV : Inorganic Chemical Industries-II
Paper No. IC-XV : Selected Topics in Industrial Chemistry
Paper No. IC-XVI(A): Pollution Monitoring and Control-II
Paper No. IC-XVI(B): Pharmaceutical Chemistry
Paper No. IC-XVI(C): Chemistry of Industrially Important Materials
Practical-VII
Practical-VIII

New Syllabus for M.Sc. Industrial Chemistry

1. **TITLE: Industrial Chemistry.**

2. **YEAR OF IMPLIMENTATION :** New Syllabus will be implemented from June 2009 on wards.

3. **Duration:**
   - The Course shall be a full time course
   - The duration of course shall be two years consisting of four semesters
4. **FEE STRUCTURE: Self Supporting Course**
   Entrance Examination Fees: As per Shivaji University rules

5. **IMPLEMENTATION OF FEE STRUCTURE:** As per Shivaji University rule
   Revision of fee Structure: YEAR-2007-08
6. **ELGIBILITY FOR ADMISSION:**
   As per O.M.Sc. 1.2 for graduates of this university and O.M.Sc. 1.3 from other Universities and the merit list.
7. **MEDIUM OF INSTRUCTION:**
   English.
8. **STRUCTURE OF COURSE:**

M.Sc. Part-I, Semester – I

Paper No.s	Subject/ paper Title	Marks		Total
		Internal	External	
IC – I	Introduction to Chemical Engineering – I	20	80	100
IC – II	General Chemical Technology – I	20	80	100
IC – III	Selected Topics in Organic Chemistry	20	80	100
IC – IV	Industrial Management	20	80	100
	Practical I		100*	100
	Practical II		100*	100
Total		80	520	600

* This includes 20 marks of seminar

M.Sc. Part – I, Semester – II

Paper No.s	Subject/ paper Title	Marks		Total
		Internal	External	
IC – V	Introduction to Chemical Engineering – II	20	80	100
IC – VI	General Chemical Technology – II	20	80	100
IC – VII	Selected Topics in Inorganic Chemistry	20	80	100
IC – VIII	Instrumental Methods of Analysis	20	80	100
	Practical-III		100*	100
	Practical-IV		100*	100
	Total	80	520	600

* This includes 20 marks of seminar

M.Sc. Part – II, Semester – III

Paper No.	Subject/ paper Title	Marks		Total
		Internal	External	
IC – IX	Organic Chemical Industries – I	20	80	100
IC – X	Inorganic Chemical Industries – I	20	80	100
IC –XI	Methods of Analysis in Industries	20	80	100
IC – XII (A)	Pollution monitoring and control – I	20	80	100
IC – XII (B)	Advanced Analytical Techniques in Industries	20	80	100
IC – XII (C)	Chemical Analysis in Agro, Food and Pharmaceutical Industries.	20	80	100
	Practical – V		100*	100
	Practical –VI		100*	100
	Total	80	520	**600**

* This includes 20 marks of seminar

M.Sc. Part-II, Semester – IV

Paper No.	Subject/ paper Title	Marks		Total
		Internal	External	
IC – XIII	Organic Chemical Industries – II	20	80	100
IC – XIV	Inorganic Chemical Industries – II	20	80	100
IC – XV	Selected topics in Industrial Chemistry	20	80	100
IC–XVI(A)	Pollution monitoring and control – II	20	80	100
IC–XVI(B)	Pharmaceutical Chemistry	20	80	100
IC–XVI(C)	Chemistry of Industrially Important Materials	20	80	100
	Practical – VII	--	100*	100
	Practical – VIII	--	100**	100
Total				600

*** This includes 20 marks of seminar**
**** This includes 50 marks of Project**

9. SCHEME OF TEACHING AND EXAMINATION:

First Year / semester – I and II

Sr. No	Subject/Paper	Teaching Scheme Hrs per weak			Total hr	Examination scheme(marks)		
		L	T	P		Theory	Practical	Total
1	IC – I/V	4	---		04	100		100
2	IC – II/VI	4	---	---	04	100		100
3	IC – III/VII	4	---	---	04	100		100
4	IC – IV/VIII	4	---	---	04	100		100
5	Practical – I/II	---	---	18	18	---	100	100
6	Practical – III/IV	---	---	18	18	---	100	100
7.	Total per semester	16	---	36	52	400	200	600

Second Year/ semester – III and IV

Sr. No	Subject/Paper	Teaching Scheme Hrs per weak L	T	P	Total hr	Examination scheme(marks) Theory	Practical	Total
1	IC – IX/XIII	4	---		04	100		100
2	IC – X/XIV	4	---	---	04	100		100
3	IC – XI/XV	4	---	---	04	100		100
4	IC – XII/XVI	4	---	---	04	100		100
5	Practical – V/VI	---	---	18	18	---	100	100
6	Practical – VII/VIII	---	---	18	18	---	100	100
7.	Total per semester	16	---	36	52	400	200	600

M.Sc. Part-I, Semester-I

Paper IC-I Introduction to Chemical Engineering-1

Unit-I

a) Themodynamics: 15

Entropy, thermodynamic definition, molecular interpretation, variation of entropy with pressure, volume and temperature, Trouton's rule, Gibb's energy, (Maxwell relations) equilibrium constants and their calculation, Effect of pressure and temperature on equilibrium, van't Hoff equation, solutions, nonideality, and partia1 molar properties.

b) Chemical Kinetics:

Kinetics of complex reactions (Equilibrium, Parallel, sequential with examples), Enzyme Catalysis, Kinetics, rate law, turnover number and examples

Unit-II Material and energy balance: 15

a) **Material balance**: Process classification, Choice of system and basis of molecular processes with chemical reactions, Material balance calculations, Multiple unit processes, Recycle and bypass

b) **Energy balance**: Forms of energy, Energy balance, Energy changes in physical processes, Energy changes in reactions, Energy balance Calculations

Unit-III Equipment Design: 15

a) **Material of constructions**: Mechanical properties, Corrosion resistance. Plastics, Ceramics. Metals and alloys, Stainless steel, Special material for food and pharmaceutical equipment. Protective coatings, Surface treatment to metals for corrosion resistance

b) **Design of Vessels**: Classification of chemical reactors, pressure vessels for internal or external pressure, Maintenance, Storage vessels for liquids and gases. Design of chemical reactors, Reactors with chemical addition, agitation, heating, removal of vapours, gas addition

Unit-IV Industrial Instrumentation: 15

I] Measurement of temperature, Thermo couples and pyrometers, High temperature thermometers, Optical pyrometers

II] Measurement of pressure and vacuum, Manometric and Bourdon gauges, Vacuum gauges, Ionization and pirani gauges. Flow measurement, Pitot tube, Rotameters

III] Liquid level indicators. Hook Type, Sight glass, Float type, Capacitance level indicator, Radiation level indicator,

REFERENCE BOOKS:

1. F. A. Henglein; Chemical technology (Pergamon)
2. J. M. Coulson, J. F. Richardson: Chemical Engineering, Vol. I, II, III (Pergamon)
3. R. N. Shreve: The Chemical Process Industries (MGH)
4. W. I. Badger and J. T. Bandchero: Introduction to Chemical Engineering (MGH)
5. O. A. Hougen, R. M. Watson and R. A. Ragetz: Chemical Process Principles (Vol. I, II (JW))
6. P. H. Groggins: Unit processes in organic synthesis (MGH)
7. A. A. Frost and R. G. Pearson: Kinetics and Mechanism
8. P. W. Atkins and Julio de Paule: Physical Chemistry, VIIth Edn. (Ostord Union press, 2002)
9. S. Glasstone: Textbook of Physical Chemistry, IInd Edn. (McMillan India LTD. 1996)
10. W. J. Moore: Physical Chemistry, Xth Edn(Orient Longmans, 1993)
11. Thermodynamics, A core course, by R. C. Srivastava, S. K. Saha, A. K. Jain Prentice Hall of India Pvt. Ltd, 2004
12. Industrial Instrumentation and Control by S. K. Singh Tata McGraw-Hill Publishing Company Limited, New Delhi.
13. Chemical Kinetics by K. J. Laidler
14. Chemical Kinetics by G. L. Agarwal

Paper IC-II- General Chemical Technology-I

Unit-I. **15**

a. Introduction to Unit Processes

b. Nitration:

Nitrating agents, Kinetics and mechanism of nitration of aromatic compounds, Nitration of paraffinic hydrocarbons, Nitrate esters, N-nitro compounds, Process equipment. Typical industrial manufacturing processes

Unit-II. Sulphonation : **15**

Sulphonating agents, Kinetics and mechanism. Desulphonation. Work-up procedures. Industrial equipment and technique, Batch and continuous processes, Manufacturing processes for detergents, dye intermediates, turky red oil etc.

Unit-III. a. Halogenation : . 1**5**

Kinetics and mechanism. Survey of methods, Catalytic chlorination, photohalogenation, Manufacturing processes for chlorohenzene, BHC, Chlorinated methanes, monochloroacetic acid, chloral, Vinyl chloride

b. Oxidation:

Oxidising agents with typical applications of each, Liquid phase oxidation with oxidising compounds, Typical manufacturing processes

Unit-IV. Esterification: **15**

Kinetics and mechanism. Esterification of carboxylic acid derivatives, Esters by addition to unsaturated systems, Industrial esterifications, Ethyl acetate, butyl acetate, Vinyl acetate, methyl methacrylate, collulose acetate, xanhate and nitroglycerin.

REFERENCE BOOKS:

1. P. H. Groggins: Unit Processes in Organic Synthesis (MGH)
2. F. A. Henglein: Chemical Technology (Pergamon)
3. M. G. Rao and M. Sittings: Outlines of Chemical Technology (EWP)
4. Clausen, Mattson: Principles of Industrial Chemistry
5. H A. Lowenheim and M. K. Moran: Industrial Chemicals
6. Kirk and Othmer: Encyclopedia of Chemical technology.
7. Kent, Riegel's Industrial Chemistry (N-R).
8. S. D. Shukla and G. N. Pandey: A Textbook of Chemical Technology, Vol-II
9. J. K Stille: Industrial Organic Chemistry (P.I I.).

Paper IC-III- Selected Topics in Organic Chemistry

Unit-I. **15**

a.Introduction to Reaction Mechanism

b. Study of the following reagents:

Lithium diisopropylamide (LDA), Dicyclohexyl carbodiimide (DCC), Lead tetraacetate (LTA), Tributyltinhydride (TBTH), Polyphosphoric acid (PPA), Trimethyl silyl iodide (TMSI), Lithium dialkyl cuprate (LDC)

Unit II.

Applications of following in synthesis: **15**

Birch reduction, Clemmensen reduction, Wolff-Kishner reduction, Sodium borohydride ($NaBH_4$), Lithium aluminium hydride($LiAlH_4$), Oppenauer oxidation, MVP reduction, use of sodium and ethanol, Phase transfer catalysts, Polymeric reagents, Electro-organic synthesis, Hydroboration.

Unit. III.

Designing of Organic Synthesis: **15**

Disconnection approach, Introduction to synthesis, synthetic equivalent, types of disconnections Regio-selectivity, Chemoselectivity, Protection of groups, reversal of the polarity (Umpolung), retrosynthesis involving synthesis of hydrocarbons, alkenes, alcohols, ethers, aldehydes, ketones, acids, esters, monocyclic, bicyclic compounds, examples of pharmaceuticals, agrochemicals, perfumary chemicals, examples

Unit IV

a. Rearrangements: **15**

Beckmann, Hofmann, Benzidine, Fries, Baeyer-Villiger, Benzilic Acid, Favorskii, Claisen, Pinacol-penacolon, Dienone-phenol

b. Stereochemistry:

Concept of chirality, optical isomerism. R & S- nomenclature, Resolution of racemic modifications, geometrical isomerism, E & Z- nomenclature, stereoselective synthesis

RECOMMENDED BOOKS:

1. E. S. Gould: Structure and Mechanism in Organic Chemistry (Holt-Reinhart Winston)
2. Peter Sykes: A guide book to Mechanism in Organic Chemistry (Orient-Longman)
3. E. L. Eliel: Stereochemistry of Carbon compounds (McGraw Hill)
4. P. S. Kalsi : Organic Stereochemistry (Wiley Eastern)
5. R.T. Morrison and R. N. Boyd: Organic Chemistry (Frentice Hall)
6. H.O. House: Modern Synthetic reactions (Benjamin)
7. K. K. Carey and R. J. Sundbarg: Advanced Organic Chemistry Vol. I & II.
8. Fieser and Fieser: Reagents for Organic Synthesis (J.W.)
9. R. E. Ireland : Organic Synthesis (Prentice Hall)
10. R. Adams: Organic Reactions : Various volumes
11. S. Warren : Designing Organic Synthesis
12. J. Fuhrhop and G. Penzlin : Organic Synthesis (VCH)
13. J. March: Advanced Organic Chemistry

Paper –IC– IV, Industrial Management

Unit I: Environmental Management of Toxic and Hazardous Chemicals 15

Introduction to toxic and hazardous chemicals, Procedure for working with substances that pose flammable or explosive hazards, Potentially explosive chemicals, Transportation of hazardous chemicals, Incineration of hazardous chemicals. Identification, classification and segregation of industrial toxic/ hazardous chemicals, hazardous chemicals, Recovery, recycling and reuse of industrially important chemicals, Safety concepts in Industry

Unit II: Small Scale Industry: R & D Technology Transfer 15

Need and scope of small scale, Industry, SSI rules and regulations, Registration, Licensing, Incentives, Factory act, Labor laws, S. T. and excise, FDA, export-import regulations, tax benefits

R & D, Technology Transfer:

Role of R and D, Functional structure of R&D Unit, Research strategies and manufacturing interface, University- Industry interface. Patents, Technology transfer.

Pilot Plant operation and scale-up:

Purpose, planning, design and operation, Analysis of results, assessment of feasibility of the design, compromises to cope-up for safety and economy in construction and operation.

Unit III: Indian Industrial Scenario and Quality Control in Industries: 15

Survey of Indian chemical industries, Indian mineral resources, ferrous metallurgy, heavy chemical industries, nonferrous metals

Fine chemicals and pharmaceuticals, natural products and agro-based chemicals, contribution of fertilizers and pesticide industries, Growth in export, Fermentation and sugar basted industries. Growth of petrochemicals

Quality Control

Role, Government standards like ISI, MINAS, Agmark, I. P., D. P., U.S. P., concepts of quality and quality control, the nature of variabilities, preparation of control charts, charts for moving averages, defects and defectives. Specification and tolerances, sampling inspection, cost reduction and quality improvement experiments.

Optimization

Unit IV: Green Chemistry and Energy Resources: 15

Introduction, What is Green Chemistry, Tools of green chemistry, Principles of Green Chemistry, Evaluating the effects of Green Chemistry, Examples of Green Chemistry

Energy Resources

Chemical, electrochemical and solar energy systems, Conventional and non-conventional energy sources, Biomass and biochemical routes of energy conversion Hydrogen storage, Fuel cell, Energy and the environment.

REFERENCE BOOKS

1. R. R. Mukharjee: Elements of Quality Control (Vani Ed Books).
2. R. H. Loster, N. C. Enrick and H. E. Mottley: Quality Control for Profit (IP).
3. W. N. Smit, E. G. Meyer and A. R. Hirsig: Industrial R. & D. Management, Ch. 1, 3, 5, 10, 11, 13, 14, 15, 18 (Marcel Dekkar)
4. A. Gerstenfield: Effective Management of R & D. (A W).
5. N. N. Singh: Scionlillc Mmuigomcnl of SSI (Lnlwani).
6. S. K. Tulsi: Incentives for Small Scale Industries (ESRS).
7. C. D.Sharma: How to start your own SSI (Vision Books).
8. Compondium of Policies and Procedure for SSI (Maratha Chamber of Commerce).
9. F. A. Henglein: Chemical safety Management and Engineering (Pergamon).
10. W. Hammer: Occupational safety Management and Engineering (PH).
11. W. Handley: Industrial safety Handbook (MGH).
12. P. T. Anastasas and J. C. Warner. Green Chemistry: Theory and Practice (Oxford University Press, 1998)
13. R.Narayan and B.Viswanathan, Chemical and Electrical Energy Systems, University Press 1997
14. B. K. Sharma Environment Chemistry.

M.Sc. Part-I, Semester-II

Paper –IC -V -Introduction to Chemical Engineering-II

Unit -I. Unit Operations- I **15**

a. Evaporation;

Types of evaporators, jacketed, horizontal and vertical tube evaporators, forced circulation evaporations, entrainment separators (upturned, deflector type, tangential type), effect of scale formation, multiple effect evaporators

b. Distillation:

Boiling and distillation, vapor-liquid equilibria, Rault's law & Henry's law, relative volatility, azeotropic mixtures, flash distillation, steam distillation, vacuum distillation, fractional distillation, plate columns (Bubble cap, Sieve plate & Valve plate)

c. Extractions:

Liquid equilibria, Extraction with reflux, Extraction with agitation, equipment, it's use and performance, continuous contact equipment, agitator extractors, packed spray extractors, Leaching, flow sheets of solid-liquid extraction, continuous leaching, counter current extraction.

Unit -II Unit Operations- II **15**

a. Filtration:

Classification of filters, Sand filters, filter press, plates & frame press, filter aids, principles of leaf filters

b. Flow of Heat:

Introduction, Conduction (Fourier law, Thermal conductivity, thermal insulation & problems), Convection (rate of heat transfer and heat transfer coefficients), Radiation (Absorptive, Reflectivity, & Transmissivity, Kirchoff's law concept of black body & examples)

c. Heat Exchange Equipments:

Introduction, Double Pipe, Shell& tube, Fixed tube, U tube heat exchangers

d. Drying:

General Principles (Significance, moisture content), Rate of drying (Constant & falling rate period, factors affecting drying), Drying equipments, Tray dryers, Rotary dryers, Single Drum dryer & Spray dryers.

Unit -III Unit Operations- III

a. Crystallization: 15

Growth of Crystal, saturation, nucleation supersaturation, (Mier's theory), Caking of crystals, effect of impurities, Classification of crystallizers, Agitated tank, Swenson walkers, Krystal, Oslo, continuous vaccum crystallizers

Unit IV Unit Operations- IV

Gas Absorption: 15

Definition, examples, comparison of absorption and distillation, conditions of liquid- gas equilibrium, solution criteria for gas absorption, mechanically agitated vessels. Packed columns, and plate columns, (Characteristics of tower packing, Types of packing) merits of plate & packed tower

REFERENCE BOOKS:

1. F.A. Henglein: Chemical Technology (Pergamon).
2. J.M. Coulson, J.F. Richardson: Chemical Engineering, Vol. I, II, III (Pergamon).
3. R.N. Shrove: The Chemical Process Industries (MGH).
4. W.L. Badger and J.T. Bandchero: Introduction to Chemical Engineering (MGH).
5. O.A. Hougen, K.M. Watson and R.A. Ragetz: Chemical Process Principles, Vol. I, II (JW).
6. P.H. Groggins: Unit Processes in Organic Synthesis (MGH)
7. G.H. Morrison & H. Freiser: Solvent extraction in Analytical Chemistry (John Wiley)
8. K.A. Gavhane: Unit operations II (Nirali Prakashan, Pune)

Paper- 1C- VI - General Chemical Technology-II

Unit I Name reactions: **15**

Aldol, Knoevenagel, Claisen, Perkin, Reimer-Tiemann reaction, Mannich, Michael, Wittig, Diels-Alder, Grignard, Stobbe condensation, Reformatsky reaction, Dieckmann reaction, Robinson annulation, Benzoin condensation, Chichibabin reaction

Unit II

a. Amination by reduction and ammonolysis: **15**

Methods of reduction to give amino compounds, Aminating Agents, Manufacture of amino compounds by reduction as well as by Ammonoloysis

b. Hydrogenation:

Catalytic hydrogenation and hydrogenolysis, Different types of catalysts, Hydrogenation equipment, Industrial hydrogenation processes

Unit III **15**

a. Hydrolysis:

Definition and Scope, Kinetics and mechanism, Manufacture of soap, fatty acids, furfural Dextrose, Ethanol, ethylene glycol, glycerol and phenol

b. Alkylation and acylation:

Alkylation and acylation at carbon, oxygen and nitrogen, Friedel-Crafts reaction, Applications of active methylene compounds like diethyl malonate, ethyl acetoacetate etc. Industrial processes

Unit IV Polymerization: **15**

Methods of polymerization, Kinetics, Relationship between structure and properties. Industrially important polymerization and polymers: Phenolic, urea, melamine and alkyl resins, Linear condensation polymers, Polycaprolactum, Nylon 6,6 Polyesters, epoxy resins, silicone and isocyanate polymers, polyethylene and polypropylene, Vinyl polymers, polystyrene, acrylate and methacrylate polymers

REFERENCE BOOKS:

1. P. H. Groggins: Unit Processes in Organic Synthesis (MGH)
2. F. A. Henglein: Chemical Technology (Pergamon)
3. M. G. Rao and M. Sittings: Outlines of Chemical Technology (EWP)
4. Clausen, Mattson: Principles of Industrial Chemistry
5. H A. Lowenheim and M. K. Moran: Industrial Chemicals
6. Kirk and Othmer: Encyclopedia of Chemical technology.
7. Kent, Riegel's Industrial Chemistry (N-R).
8. S. D. Shukla and G. N. Pandey: A Textbook of Chemical Technology, Vol-II
9. J. K Stille: Industrial Organic Chemistry (P.I I.).
10. E. S. Gould: Structure and Mechanism in Organic Chemistry (Holt-Reinhart Winston)
11. Peter Sykes: A guide book to Mechanism in Organic Chemistry (Orient-Longman)
12. H.O. House: Modern Synthetic reactions (Benjamin)
13. R.T. Morrison and R. N. Boyd: Organic Chemistry (Frentice Hall)

Paper- IC- VII - Selected Topics in Inorganic Chemistry

Unit-I: Industrial Applications of Organometallic Compounds 15

Importance of Organometallic compounds as catalysts, Conditions to be satisfied by a metal to act as catalysts, Hydrogenation of Olefins, Importance of Wilkinson's catalyst, Prepration of the Catalyst, $[RhCl(PPh_3)_3]$, Role of Rhodium Metal in the Catalytic Process, Mechanism of Hydrogenation of Olefins using Wilkinson's Catalyst, Modification over the original catalyst, Hydroformylation of olefins-The Oxo process, Mechanism of Hydroformylation of Olefins using the original catalyst, $HCo(CO)_4$, Modification the original catalyst, Mechanism of the Modified catalysis, Isomerisation of Olefins, Mechanism of Olefin Isomerisation, Oxidation of Olefins- Wacker's Process, Step involved Wacker's Process, ß- elimination,

Factors retarding the ß- elimination process, Role of palladium in Catalysing the oxidation of Ethene to Ethanal, Polymerisation of olefins Ziegler-Natta Catalysis, Heterogenous Catalysis, Homogeneous Catalysis, Importance of Ziegler-Natta Catalysis, Mechanism of Ziegler-Natta Catalysis, Cyclo-oligomerisation of Acetylenes- Reppe's Catalysis, Fischer- Tropsch Synthesis, Mecanism of Fischer- Tropsch Synthesis, Water gas Shift Reaction, Mechanism of Water gas Shift Reaction.

Unit-II: Synthesis and characterization of solid state materials: 15

Synthesis of solid state materials, Conventional methods, electro-deposition, spray pyrolysis, sol-gel, hydrothermal synthesis, Chemical deposition, magnetic sputtering, Photo enhanced CVD, Plasma, LASER CVD, Low pressure CVD. Material characterization, electrical, optical, magnetic and thermal properties and chemical compositional analysis EDAX, AAS, Spectrophotometric, Crystal growth from vapor, melt and solution, Purification methods, concept of ultrapurity preparation of ultrapure elements Ga, In, Si, Ge and As for semiconductor

Unit- III: Nanotechnology and its applications: 15

Introduction to nanoscale, potential applications, Challenges and opportunities Growth of nanocrystalline materials, Nanocrystals in inorganic matrices, glass matrices, dilusion controlled growth. Nanocrystals in porous glasses, Semiconductor nanocrystals in zeolites. Composite - semiconductor glass films inorganics in organics. Semiconductor nanocrystals in organic solutions and in polymers. Nanocrystals on

crystal substrates. Self organized growth. Synopsis of nanocrystals fabricated by various techniques. Special properties and applications of nanocrystalline solids

Unit –lV: Bio-lnorganic Chemistry: 15

Essential elements in biological systems, Classification of biomolecules containing metal ions, Biological roles of metal ions like Na, K, Ca, Fe, Co, Oxygen transport and storage, Acid and redox catalysis biological system, Co-enzymes, Vitamin B12 Nitrogen fixation and photosynthesis.

REFERENCE BOOKS:

1. J. E. Huheey : Inorganic Chemistry (Harper & Row)
2. J. D. Lee: New Concise INORGANIC Chemistry (ELBS).
3. F. A. Cotton and J. Wilkinson: Inorganic Chemistry (JW).
4. J. Mukhlyonov : Catalyst Technology (M1R).
5. N. B. Hannay : Solid State Chemistry (PH).
6. Z. Wife, R. Speights : Ultrapurity (MDI).
7. J. M. Thomas and W.J. Thomas: Introduction to Principles of Heterogenneous Catalysis (A.P.)
8. F.A. Kroger: Chemistry of Imperfect Crystals.
9. C. Satteefield: Heterogenneous Catalysis in Practice (MGH).
10. F. Basolo and R. G. Pearson: Inorganic Reaction Mechanism (JW).
11. M. L. Tobe: Inorganic Reaction Mechanism (Nelson, London).
12. H. Taube: Electron Transfer Reaction of Complex Ions in Solution (AP).
13. Benson: Inorganic Reaction Mechanism in Solution (MGH).
14. H. Gopanov: Optical and Electronic Properties of Nanocrystalline Materials.
15. A. Arora: Industrial Management of Toxic and Hazardous Chemicals.
16. R. Gopalan and V. Ramalingam: Concise Co-ordination Chemistry: Vikas Publishing House, Pvt. Ltd.
17. D. Banerjee: Co-ordination Chemistry, IInd Edition, Asian Books Private Limited.
18. Daniel Minoli: Nanotechnology Applications to Telecommunication Networking.
19. T. Pradeep: Nano: The Essentials of Understanding, Nanosciences & Nanotechnology, McGraw-Hill Education.

Paper –IC- VIII -Instrumental Methods of Analysis:

Unit-I Optical Methods: **15**

a) U-Visible Spectroscopy :

Introduction to spectroscopy, Electromagnetic spectrum, Interaction of electromagnetic radiation with molecular system, Electronic excitation, Beer-Lambert law, molar extinction coefficient, Chrophores and auxochromes, Absorption of simple chromophores. Instrument, applications to quantitative analysis

b) IR Spectroscopy:

Modes of vibrations, instrument, sampling techniques, selection rules, Absorption frequencies of common functional groups, Application to structure determination, monitoring reactions.

Unit II: **15**

a) Atomic Absorption Spectroscopy (AAS):

Introduction, principle, instrumentation, detection limits, sensitivity, interferences, comparison of AAS with flame photometry, applications.

b) Fluorescence and Phosphorescence:

Basic principles filter fluorometer and double beam monochromator instruments, working, analysis of rare earths, pharmaceuticals, optical brightness, ultra trace analysis, new materials.

c) Mass Spectrometry:

Introduction, Ion formation, Mass spectral fragmentation of organic molecules, Mac-Lafferty, rearrangement of isotope ions, nitrogen rule the moss spectral fragmentation of organic molecule for structure determination.

d) Mössbauer Spectroscopy:

Introduction, principle, Mössbauer nuclides, parameters required for evaluation, instrumentation, applications.

Unit-III. Electroanalytical Methods: **15**

a) Ion-selective electrodes: Principle, equation for potentials, glass membrane electrodes, gas sensing electrodes, advantages and applications

b) Polarography: Basic principles, current-voltage relationships, residual,

migration, diffusion and limiting currents. Dropping mercury electrode, half wave potential, Ilkovik equation, Instrumentation, Applications in qualitative and quantitative analysis. Amperometric titrations.

Unit-IV. Advanced Chromatographic Techniques **15**

Principles, instrumentation and applications of GC, GCMS, HPLC, HPTLC & SFC

REFERENCE BOOKS:

1. A. I. Vogel: A Textbook of Quantitative Inorganic Analysis (Longmans).
2. H. H. Willard, L.L. Merritt, J.A. Dean and Settle: Instrumental Methods of Chemical Analysis (DVN/AEWP).
3. H. F. Walton: Principles and Methods of Chemicals Analysis (PH).
4. G. H. Morrison and H. Freiser: Solvent Extraction in Analytical Chemistry (JW).
5. T. Sekine and Y. Hasegawa: Solvent Extraction Chemistry (Marcel Dekker).
6. F.J. Welcher: Standard Methods of Chemical Analysis (DNV).
7. S. Glasstone: Electrochemistry (D.Van Nostrand).
8. V. M. Parikh: Absorption Spectroscopy of Organic Molecules (D.Van Nostrand).
9. I. M. Kolthoff: Treatise in Analytical Chemistry Vol. I-VII.
10. A. I. Vogel: Quantitative Organic Analysis (Longmans).
11. S. M. Khopkar: Basic Concepts of Analytical Chemistry (JW).
12. D. Skoog and D. West: Principles of Instrumental Analysis (Holt Sounders).
13. H. Kaur: Instrumental Methods of Chemical Analysis: Pragati Prakashan, Meerut.
14. H. Kaur " Spectroscopy' Pragati Prakashan
15. H. Kaur Introduction to Chromatography.
16. Willium Kemp ' Organic Spectroscopy' Palgrave.
17. G. R. Chatwal, S. K. Anand. Instrumental Methods of Chemical Analysis, Himalaya Publishing House.
18. D. H. Williams & I. Fleming, Spectroscopic Methods in Organic Chemistry. Tata McGraw Hill.

M.Sc. Part-I, Semester-III

IC - IX: Organic Chemical Industries – I

Unit – I: Dyes, Pigments and Intermediates: (15)

a) Classification of Dyes.
b) Preparation of important dye intermediates.
c) Methods of preparation of commercial dyes of different classes with suitable examples. Typical manufacturing processes of few dyes.
d) Fluorescent brightening agents.
e) Special dyes: Photosensitive dyes, dyes as food additives, natural dyes.

Unit – II **(15)**

A) Perfumary.

Compounds used in perfumery and their classification. Methods of preparation and importance, phenyl – ethanol. Yara yara. Ionone musk ketone, musk ambrette, musk xylene. Phenylacetic acid and its esters, benzyl acetate, synthetic musks, jasmine.

B) Essential oils:

Source, constituents, isolation and uses.

C) Cosmetics:

Detailed study of formulations and manufacturing of cream and lotions, Lipstick and nail polish, Shampoos, hair dyes and tooth pastes.

Unit – III **(15)**

A) Oils, soaps and Detergents:

Refining of edible oils, Manufacturing of soaps, Detergents, Liquid Soaps. Manufacturing of fatty Acids and glycerol, greases from fatty acids, turkey – red oil

B) Paints, Varnishes and Inks.

Constitutions, examples of preparation and applications.

Unit – IV **(15)**

A) Isolation of Natural Products of commercial importance:

Methods used. Isolation of nicotine from tobacco waste, Citric from lemon grass, Neem extract and eucalyptus oil.

B) Synthesis of Natural Products:

Mono and Sesqui – Terpenes.

Reference:

1. K. Venkatraman: The Chemistry of Synthetic Dyes Vol. 1-7 (A.P)
2. Abranart: Dyes and Their intermediates (Pergaman)
3. Beech: Fiber reactive Dyes (Logos Press)
4. Frig and David – Dyes intermediate
5. Allan: Color Chemistry
6. Kent: Riehels Industries Chemistry.
7. B. Billot and F.V. Wells- Perfumary Technology (JW)

8. M Ash & I Ash: A formulary of cosmetic preparation (Godwin)
9. M Ash & I Ash: A formulary of paints & other coatings.
10. P.H. Groggings: Unit Processes in organic synthesis (MGH)
11. Kiik & other: Encyclopedia of Chemical technology.

IC – X Inorganic Chemical Industries – I

Unit –I: Inorganic Heavy Chemical Industries. ***(15)***

Chemical industries: production, basic raw materials, transportation picture for India. Manufacturing process: Physicochemical principles, Quantitative requirements, flow sheet, chemical reactions, uses of following heavy chemicalsSulphuric acids (contact process), ammonia, nitric acid (ammonia oxidation process)Chlor – alkali industries – soda ash, caustic soda and chlorineChemicals from sea

Unit – II: Industrial Catalysis – Principles and applications : ***(15)***

Basic principles of catalysis: adsorption isotherms, surface area pore size and acid strength measurement.Enthalpy and entropy of adsorption: interpretation of chemisorptions based on the structure and the nature of the solid – solid state theories – role of defects in catalysis.Kinetic of surface reactions: rate determining step, various type of reaction, simple, parallel and consecutive reactions.

Selection, preparation and evaluation of catalysts – test reaction, promoters, carriers and stabilizers. Mechanism of selected reactions: hydrogenation, decomposition of nitrous oxide, oxidation of CO- etonization of carboxylic acids, cracking of hydrocarbons. Applications: Petrochemical industry – reforming and refining – value added chemicals environment protection auto exhaust catalyst Novel catalytic material clusters, zeolites, mesoporous materials.

Electro catalysis and Photo catalysis: Solid Liquid interfaces

Techniques in catalysis.

Unit – III: Material for Applications ***(15)***

Refractories, classification, manufacture, clays, ceramics, dielectric materials, Portland Cement, lime, mortar, alumina, pigments

Unit – IV: Bio-fueles ***(15)***

Introduction, types of biofuels (Bioethanol, Biodiesel), raw materials for the synthesis of Bio fuel, properties of bio fuel, Biofuel and the environment (Emissions from biofuels), Biofuels and economy, standard specification of biofuel, Biofuels and future.

Reference:

1. F A Henglein: Chemical Technology (pergamon)
2. R.W. Thomas and P. Farago: Industrial Chemistry (HEB)
3. R.N. Shreve: Chemical processes Industrial (MGH)
4. J.D. Gilchrist: extraction metallurgy (Dergamon)
5. Riegels: Industrial Chemistry (Reinhold)
6. D.S.T.Prespective in scuience and technology Vol. I&II (Vlkas)
7. W.H.Dennis: Foundation of Iron and steel metallurgy (Elsevier)

8. Kirl R Smith Biofuels, Air Pollution and Health, A Global Review
9. Plant Oils as fuels: Present state of science and future Developments Edited In
10. Bio fuels and Industrial Products from Jatropha curcas Ed. G Gubutz, M.Mittelbach. M Trabi VDbV – Verlag fur die Technische Universitat Graz, Graz., 1997, ISBN 3-7041-0242-3

IC-XI:Methods of Analysis in Industries

Unit – I: Chemical analysis in Industries: ***(15)***

Role of chemical analysis in process development, Quality control, process, control ateach stage of production, bye products, acceptance of raw materials, effluent monitoring and control for finding out causes of failure or manufacturing, noninstrumental,instrumental, optical, electochemical, and thermal methods of analysis.

Unit – II: Non – Instrumental Methods ***(15)***

a. Volumetric analysis: Acid – Base titration, analytical standards, redox titration, visual indications, complexometrioc titration, precipitation titration – MnO2 in pyrolucite Na2CO3, and NaOH, Na2CO3, mixture analysis.
b. Gravimetric analysis: Correct procedure of precipitation, filtration, washing, drying, ignition, and washing of the precipitate, Fe+++, Zn++ ions, ash content of food stuff.

Unit – III: Thermal and Radiochemical Methods: ***(15)***

a. TGA: Chemical changes versus weight loss plots, TGA and DTA analysis, use in characterization of raw materials, minerals, polymers, hydrate analysis, DSC, Principal, instrumentation and application.
b. ***Radiochemical Methods:*** Nuclear reactions and radiation, radioactivity, detection of radiations, G.M.counter,scintillation counter, applications of radio – nuclides, neutron activation analysis (NAA) & applications of this technique.

Unit – IV: ***(15)***

A) Gas and Fuel analysis:

Orsat apparatus and its use in gas analysis, bomb calorimetry, coal analysis, calorific value of fuels.

B) Chemical Analysis of surfaces :

Ion Scattering Spectroscopy, Secondary Ion Mass Spectrometry, Auger Electron Spectroscopy, Electron Spectroscopy for Chemical Analysis. Basic principles, Instrumentation and applications of these techniques.

Reference:

1. F.J.Welder: standard Methods of chemical analysis Voil. III Part A&B
2. H.A. Strobel chemical instrumentation (AW)
3. Willard, Merrit & Dean, Instrumental Methods of analysis (FWAP)
4. F.D. Snell, Encyclopedia of Industrial : Chemical Inorganic analysis Vol. 1 to 20 (J.W)
5. Hillebrand, Lhundell and Hoffman: Applied inorganic analysis (Interscience)
6. D.K. Chakrabarty: Solid state Chemistry
7. H. Kaur, Instrumental method of analysis.

IC XII (A): Pollution monitoring and control – I

Unit – I: Regulatory aspects ***(15)***

Industrial emissions, liquids and gases, pollution caused by various chemical industries and its overall effect on quality of human life and environment. Environmental legislation, water (prevention and control of pollution) Act1974. its implication, applications and effectiveness in industrial pollution control, water quality management in India, Indian standards, IS – 2490, IS – 33660, IS – 2296, MINAS for sugar industries, distilleries, synthetic fiber industries, oil refineries, pesticides industry and mercury from chloralkali industry, Air (Preventation and control of pollution) Act 1981, good analytical practices for proper assessment of pollutions, Management of regulatory requirements.

Unit – II: Pollution and its measurement: ***(15)***

Nature of industries effluents, gaseous and liquid effluents, methods of gas analysis, analysis of CO, CO2,SO_2, NO_2,S, Cl_2, in the gaseous effluents, particulate matter, particle size analysis AAS applications, processing of water, the free acids and bases dissolved organic and inorganic compounds like alkali and alkaline salts, SO_4,PO_4, NO_2 NO, determination of iron and calcium, suspended solids, total cations and anion, estimation of industrial metals, recovery techniques, Organic trace chemicals in waste water, volatile carcinogenic matter in waste water, recovery and recycling techniques, biological methods of waste water treatment.

Unit – III: Waste water Treatment ***(15)***

1. Physical Methods.

Reverse Osmosis, electrodialysis, membrane filtrare,

2. Chemical methods:

i) Carbonates
ii) Hydroxides
iii) Sulphides

3. Biological methods

Biodegradable materials and removal of pollutants by microorganisms, methods of waste treatment, analytical studies, food for microorganism in waste water, BOD and its measurement, activated sludge process.

Unit – IV: Instrumental Techniques in Environmental Analysis ***(15)***

Introduction, X – ray fluorescence, Electrochemical methods, chromatographic techniques- Gas Chromatography, HPLC, Absorption spectroscopy, Monitoring techniques and methodology.

Reference:

1. A.C. Stern Air pollution, Engineering control Vol. (IV) A.P
2. P.N. Cheremisioff and R A Yound : air pollution control and design hand book Vol – I &II Dekker.
3. Liptak: Air pollution S P Mahajan: Pollution control in process industries (MH)

4. S.P. Mahajan: Pollution control in process Industries (MH)
5. Wark & Warnor : Air Pollution Origin & Control
6. A. K. De: Environmental Chemistry
7. S.M. Khopkar: Environment pollution analysis
8. K.S. Ramlho: Introduction to waste water treatment process(A.P)
9. M.J. Hammar: Water and waste water Technology (J.W)
10. R. Horne: Environmental chemistry, Wiley

ICXII (B): Advanced Analytical Techniques in Industries

Basic theory, Instrumentation, Laboratory technique and Applications of following methods

Unit – I: X – ray Methods. ***(15)***

Diffraction, Fluorescence, absorption, & emission spectroscopy.

Unit – II: Thermoanalytical Methods: **(15)**

a. Therogravimetric Analysis
b. Differential Thermal Analysis
c. Differential scanning calorimetry

Unit – III: ElectroAnalytical Methods. **(15)**

Coulometry, Polarography, Amperometry, Electrogravimetry.

Unit – IV: Radiochemical Methods of analysis: **(15)**

Radiation Dosimetry, Radiolysis of water, Free Radicals in Water Radiolysis, Radiolysis of some aqueous solutions, A time scale of Radiolytic Events

Radiation-induced Color Centers in Crystals: Storing and release of Energy.

Reference:

1. H J Arnikar: Essential of Nuclear Chemistry
2. R.D. Braum, Introduction to Instrumental Analysis.
3. Willard, Deritt, Dean and Settle, Instrumental methods of Analysis
4. G.W. Ewing, Instrumental Methods of Analysis 4^{th} and 5^{th} editions.
5. Chatawal and Anand, Instrumental Methods of Analysis.

IC -XII(C): Chemical Analysis in Agro, Food and Pharmaceutical Industries.

Unit – I :Analysis of soil & Fuel : (15)

Analysis of soil: Moister, pH, total nitrogen, phosphorous, silica, lime, Magnesia, Manganese, sulfur & alkali salts.

Fuel analysis: Solid, liquid and Gas , ultimate and proximate analysis heating values , grading of cool , liquid fuels , flasks points , aniline point , octane number and carbon residue , gaseous fuels – producer gas and water gas – calorific value.

Unit- II : Clinical Chemistry and drug analysis: (15)

Composition of blood collection, and preparation of samples, clinical analysis – serum electrolytes, blood glucose, blood urea nitrogen , uric acid , albumin , globulin , barbiturates , acidic and alkaline phosphates , Immunoassay , principals of radiimmunoassy and applications . The blood- gas analysis – trace elements in the body.

Drug analysis: Narcotics and dangerous drugs, classification of drugs, screening by gas m thin layer chromatography and spectrophotometric analysis.

Unit – III: Food analysis : (15)

Moister, ash, crude protein, fat, crud fiber, carbohydrate, calcium, potassium, sodium, and phosphates, food adulteration – common adulteration in food, contamination of food stuffs, microscopic examination of foods for adulterants, Pesticide analysis in food products, Bxdraction and purification of sample, HPLC, gas chromatography for organo – phosphates, thin layer chromatography for identification of chlorinated pesticides in food products

Unit –IV:Fluorescence in Biological, Medical and Drug Development (15)

Fluorescence instrumentation for analysis, flurophors and their modification , pH – indicators , membrane potential probes , lipid membrane protein, labeling of protein and DNA.

Recommended Books:

1. Fundamentals of analytical chemistry by D. A. Skuog , D. M. West and F. J. Honer, W. B. Saunders.

2. Chromic phenomenon , The Technological application of color chemistry Peter Bamfield .

M.Sc. Part-II Sem –IV

IC – XIII: Organic Chemical Industries – II

Unit – I: Drugs, Pharmaceuticals and Pharmaceuticals analysis ***(15)***

a. Classification of drugs based on activity.
b. Synthetic procedure for the present commonly used drugs of each type, Manufacturing of few important drugs.
c. Semi synthetic penicillins.
d. Vitamins: type of vitamins, synthesis of Vit – A and Vit – E, Vitamin – II of niacinamide
e. Use of NMR in structure determination of drugs and pharmaceuticals: Instrumentation and Applications.

Unit – II: Agrochemicals: ***(15)***

a)Organophosphorus pesticides: Malathion, Monocrotophos, dimethoate, chloropyriphos, Dichlorpyriphos, Dichlororous, phenthoate.
b)Carabamates: Carbonyl, Bygon, Zirman, Zineb, Maneb, Alaicarb.
c)Pyrenthroids: Natural pyrenthrins: Isolation and structures, synthetic **Pyrethroids:**
Allethrin, cypermethrin, Phenvalerate.
d)Insect Peromones and Repellants: peromones, general introduction and applications in integrated pest management (No Synthesis). Repellents: Survey and synthesis and synthesis of the repellents: N,N, Diethyl - 3methyl Benzamide, N,N,Diethyltoluamide, 2 – Ethyl -1,3 hexanedial, Butopytranexyl. Dimethylcabonate, Dimethylphthalate. Use Pheromones in post management.
b. Plant growth regulaters and Herbicides: General survey of IAA, β – Napthoxyacetic acid, 2,4, - D Malic hydrazide, Daminozide, paraguat, glyphosine.

Unit – III: Petrochemicals: ***(15)***

Petroleum refining, outline of chemicals derived from ethylene, xylene and naphthalene.

Unit – IV: Polymers: ***(15)***

Mechanism of polymerization, study of polysters, polyamides, PVC, Polystyrene, Polyvinyl acetate, and polyvinyl chloride, polyethylene, viscose rayon, synthesis of polyethylene, synthetic rubbers, styrene – butadiene, butylisopropene, phenol formation, formldehyde resion, plasticizers and oxidants for polymers, natural polymers, starch and cellulose.

References:

1. Text Book of Polymer science, F.W.Billmeyers Jr Wiley
2. Polymer Science, V.R.Gowarikar, N. V. Vishwanathan and J Shreedhar, Wiley
3. Functional monomers and polymers, K. Takemote, Y Inkiand R m Ottanbrite.

4. contemporary Polymer Chemistry, H.R.Alcoek and F W Lambe, Practice Hall.
5. Physics and chemistry of polymers, J M G,Cowie, Blackie, Academic and Prfessinoal.
6. Burger : Medicinal Chemistry (I.W.)
7. W.O. Foye: Principal of Medicinal chemistry (I.E)
8. Lendieer and Mitscher: The organic chemistry of drug synthesis (I.W)
9. N.N.Melnikow: Chemistry of Pesticides (Springer)
10. M.B. Green, G.S.Hartley West: Chemicals for crop protection and pest managements (pergamon)
11. R. Cremlyn: Pesticides
12. K.H. Buchel: Chemistry of Pesticides.
13. H.B.Scher: Advances in pesticides formulation Technology (ACS)
14. Kirk and other: Encyclopedia of chemical Technology
15. S.D.Shukla and G.N. Pandey: Text Book of Chemical technology. Vol. II

IC-XIV:Inorganic Chemical Industries – II

Unit – I: Special materials for Electronic Industry: ***(15)***

a. Ferrites and magnetic materials.
b. Phosphorus for various uses, Luminous paints.
c. High purity Silicon, Germanium, Gallium, Indium and Arsenic.
d. Alloys for various uses in electrical and electronic Industry.
e. High temperature materials.
f. Alloy and ceramics superconductors.

Unit – II: Fertilizer Industries. ***(15)***

General Principles of plant Nutrition: Essential plant nutrients, functions of the essential elements, classification of commercial nitrogenous fertilizers.
Classification, manufacture of ammonium sulphate, Urea, Ammonia nitrate fertilizers
Commercial phosphatic fertilizers.
Classification, manufacturing process and properties of phosphatic fertilizers, single super phosphate, triple super phosphate, manufacturing of phosphoric acid by electric furnace process.
Commercial potassic fertilizers:
Chemicals of potassium compounds, classification, manufacturing process and properties of potasium fertilizer, mariate of potassium, potassium sulphate, mixed fertilizer. Micronutrients: Role and deficiency symptom of micronutrients.
Biofertilizers: classification, demands and production,
Position of fertilizer Industries in India.

Unit – III: Metal Finish Technology: ***(15)***

Electro refining of metals, electroplating of nickel, chromium, copper, cadmium, silver and Gold, surface treatment technology, surface coats.

Unit – IV: ***(15)***

A. Glass and Refractory materials:
   Raw materials, Sodaglass, borosilicate glass, Lead Glass, Colored Glass, Refractory: Raw materials, clay potys, Zeolotes.
B. Industrial Gases:
   Manufacture and industrial uses of H_2, O_2, N_2, CO_2 & acetelene. Liquefaction of gases, production of low temperatures,
C. Chemicals of Utility:
   Inorganic fine chemicals, magnesia, alumina, AlCl3, calcium carbonate, sodium silicate, MnO2,FeSO4,PbO2,Na2HPO4 and NaOH.

Reference:

1. Lowenheim F A (1974) Modern Electroplating III Ed Chapman & Hall, Landon.
2. Gable, D: Principal of metal Treatment and protection. Pergaman, Press Oxford (1978)
3. G.A. Keneth: Electroplating for Engineering's A Hand Book IIIrd Edn Van Nastrad Reinbold Co London
4. F A Lowinbein: Modern Electroplating, Electroplating Publication New Jersey
5. Burke Progess in ceramic science Vol. IV
6. R.R.Iash: afromulary of paints and other coating Vol. I
7. J.D. Gilchrist: Extraction Metallurgy (Pergamon)
8. W.H. Dennis: Foundation of steel and iron Metallurgy (Elsevier)
9. S.D. Shukla & G N Pandey: A text book of chemical technology Vol. 1
10. F A. Henglein: Chemical Technology (Pergamon)

IC-XV: Selected Topics in Industrial Chemistry

***Unit – I: A*dsorption and catylsis:** (15)

General properties of catalysis, physical adsorption and chemical adsorption, kinetics of chemisorption, theories of adsorption, catalysis kinetics of heterogeneous catalysis, absolute reaction rate theory, preparation catalyst, catalyst and shape, Piisoning and catalyst fouling, Determination of surface area.

Unit-II: **Science of corrosion and corrosion control*:*** ***(15)***

Introduction, economic aspects of corrosion, theories of corrosions , facter affecting corrosions, kinetics of corrosion, Evans diagram, thermodynamics of corrosions, Fourbaix diagram, corrosions testing techniques, Evaluation of corrosions effect: XRD, ESCA, FTIR surface techniques.

Corrosions Prevention: Corrosion inhibitors, protectve coating, cathodic and anodic protection.

Corrosion problem in India.

Unit – III: Mechanical and Rheological Properties of polymers: ***(15)***

Mechanical Properties, tensile strength, stress and strain curves, Maxwell voit model, Boltzmann superposition principle, Impact strength, compressive strength,

ultimate polymer properties and structure relationship, Elastomers, Fibers, and Plastics. Rheological Equation of state (RES) fluid – ideal, non- Newtonian, viscous flow, viscoelastic behavior, creep, stress relaxation, dynamic mechanical behavior, Maxwells model, mechanical spectra.

Unit – IV: Sensor Technology: (15)

Introduction, recent trends, classification of sensors, Elector analytical sensors, sensor, electrodes, Metal Membrane electrode sensors, Ionic Conductors, Thin film and thick Film Sensors, Nano - sensors, Application of sensors in Industry.

Reference:

1. Adamson: Surface Chemistry
2. D.D. Deshpande: Polymer science
3. Bilmayer: Polymer Science
4. N.B.Hanny: Solid state chemistry
5. S. Glastone: Physical chemistry
6. J.O.M.. Bokries & A.K.N. Reddy: Modern Electrochemistry Vol – I & II
7. J.D.Lee: Inorganic Chemistry.
8. N.N.Greenwood: Chemistry of Elements
9. D. Patranabis: Sensor and Tranducers.

IC-XVI (A): Pollution monitoring and control – II

Unit – I: Removal of heavy toxic metals: (15)

Metallic and non-metallic pollutants, Cr,Hg,Pb,Cd,Cu,As etc. Their physiological manifistation, source, analysis and control of inorganic compounds. Effect of heavy toxic metals on living organisms, Chromium, Merqury, Lead, Cadmium, Arsenic analytical methods of determination of small amounts of the metal pollutants, copper recovery, treatment of waste to remove heavy metals, recovery techniques.

Unit-II: Removal of Phenolic residue:

Sources of Phenolic residues, Analytical methods, treatment by using stream gas stripping, ion – exchange, solvent extraction, oxidation methods, Microbiological treatment General nature of organic residue not mentioned so far. Role of vapor pressure, role of solubility, effect of pH on solubility extractive methods of recovery and recycle, Chemical methods of conversion to less soluble nontoxic or biodegradable products, carcinogens,

Economics of recovery and recycle methods.

Incineration of nonrecyclable concentrates and residues.

Unit – III: Removal of sulphur dioxide and Nitrogeneous pollutants: (15)

Origin of SO2 and its hazard, Analysis of SO2, SO2 control methods, desulphurization of fuels, Indian cola and Indian Crude oil. Economics of SO2 control measures NOx, dissolved NOx, nitrites, ammonia, Urea and other nitrogene containing compounds in the

effluents fertilizer explosive, industrial effluents, effluents from nitro aromatic industries, analytical methodology, Photochemistry of air pollution.

Unit-IV: (15)

A***) Biotechnology in Chemical Industry:***

Essential elements in biological system, mettallo – proteins and mettallo–enzymes. Metal ions as a charge carriers Health effects due to deficiency and excess of metals and non-metals Biotechnology for the production of chiral compounds. Role of biotechnology in Industry.

B) Removal of Particulate matter:

Particulate matter and dynamics of particles separations, Particulate matter in gas sream, filtering, gravity separation, liquid scrubbing cyclone separations, electrostatic precipitations safety of workers analysis of particulate matter.

C) Polymer recycling:

Environmental and polymer Industries. Recycling of polymer waste.

Reference:

1. S.P. Mahajan: Pollution control in processes iIndustries (J.W)
2. P.N.Chennsioff and R. A Young: Air Pollution control and design Hand Book and recovery (J.W)
3. J.R. Holmes: Refuse recycling and recovering (J.W)
4. M. Sitting: Resources recovery and recycling Hand Book and Industrial Wastes (NDS)
5. J.O. Niagh: Sulphur in the Environment Vol. I & II (J.W)
6. P.S.Minor: The Industry/EPA controntation (MGH)
7. R.B.Pojaselc: Toxic and Hazardous waste disposal Vol. I &II (AAS)
8. S.M.Khopkar: environmental pollution analysis
9. A.K.Dey: Environmental Chemistry
10. W.Handley: Industrial safety Handbook
11. J.E.Huheey et. Al. Inorganic Chemistry, 1993
12 J.E.Huneey etal. (1993) Inorganic Chemistry.

IC – XVI (B) :Pharmaceutical Chemistry

Unit – I : Drug Design ***(15)***

Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrugs and soft drugs, structure-activity relationship (SAR), factors affecting bioavtivity, resonance, inductive effect, isosterism, non-isosterism, special considerations. Theroies of drug activity: occupuancy theory, rate theory, induced fit theory. Quantiative structure activity relationship. History and development of QSAR. Concepts of drug receptors. Elementary treatment of drug receptor ionization constants, steric, Shelton and surface activity parameters and redox potentials. Free-Wilson analysis, Hansch analysis, relationships between Free-Wilson and Hansch analysis. LD-50, ED-50 (Mathematical derivations of equations excluded).

Unit – II: ***(15)***

A.Pharmacokinetics

Introduction to drug absorption, disposition, elimination using pharmacokinetics, important pharmacokinetic parameters in defining drug disposition and in therapeutics. Mention of uses of pharmacokinetics in drug development process.

B. Pharmacodynamics

Introduction, elementary treatment of enzyme stimulation, enzyme inhibition, sulphonamides, membrane active drugs, drug metabolism, xenobiotics, biotransformation, significance of drug metabolism in medicinal chemistry.

C. Antineoplastic Agents

Introduction, cancer chemotherapy, special problems, role of alkylating agents and antimetabolites in treatment of cancer. Mention of carcinolytic antibiotics and mitotic inhibitors.

Sysnthesis of mechlorethamine, cyclophophamide, melphalan, uracil, mustards, and 6-mercaptopurine. Recent development in cancer chemotherapy. Hormone and natural products.

Unit – III ***(15)***

A. Cardiovascular Drugs

Introduction, cardiovascular diseases, drug inhibitors of peripheral sympathetic function, central intervention of cardiovascular ooutput. Direct acting arteriolar dilators.

Synthesis of amyl nitrate, sorbitrate, diltiazem, quinidine, verapamil, methyldopa, atenolol,

B. Local Antiinfective Drugs

Introduction and general mode of action.

Synthesis of sulphonamides, furazolidone, nalidixic acid, ciprofloxacin, norfloxacin, dapsone, amino salicylic acid, isoniazid, ehtionamide, ethambutal, fluconazole, griseofulvin, chlroquin primoquin.

Unit – IV ***(15)***

A. Psychoactive Drugs- The Chemotherapy of Mind

Introduction, neurotransmitters, CNS depressants, general anaesthetics, mode of action of hypnotics, sedatives, anti-anxiety drugs, benzodiazipines, buspirone, neurochemistry, of mental diseases. Antipsychotic drugs-the neuroleptics, antidepressants, butyrophenones, serendipity and drug development, stereochemical aspects of psychotropic drugs.

Synthesis of diazepam, oxazepam, chlorazepam, alprazolam, phenytoin, ethosuximide, trimthadione, barbiturates, thiopental sodium, glutethimide.

B. Antibiotics

Cell wall biosynthesis, inhibitors, β-lactum rings, antibiotics inhibiting protein synthesis.

Synthesis of penicillin G, penicillin V, ampicillin, amoxicillin, chloramphenicol, Cephalosporin, tetracycline and streptomycin

References:

1. Introduction to medicinal chemistry, A Gringuage, Wiley- VCH.
2. Wilson Gisvold's Text book of organic Medicinal and pharmaceutical Chemistry, Ed. Robert F.Dorge.

3. An introduction to drug design, S. S. Pandeya and J. R. Dimmock, New age International.
4. Burger's Medicinal Chemistry and Drug Discovery Volume 1 (Chap. 9 and Chap.14), Ed.M.E. Wolff, John Wiley.
5. Goodman and Gilman's Pharmacological Basis of Therapeutics, Mc Graw-Hill.
6. The organic Chemistry of Drug Design and drug action, R.B. Silverman, Academic press.
7. Strategies for Organic Drug synthesis and Design, D. Lednicer, John Wiley.

IC-XVI (C): Chemistry of Industrially Important Materials

Unit – I: A) Industrial Materials ***(15)***

Glasses, Ceramics, Composites and Nonmaterial's
Glasssy state, glass formers and glass modifiers, applications. Ceramic structures, mechanical properties, clay products. Refractories, characterizations, properties and applications.
Microscopic composites; dispersion-strengthened and particle-reinforced fibre-reinforced composites, macroscopic composites. Nanocrystalline phase, preparation phase, preparation procedures, special properties, applications.

B) Thin Films and Langmuir-Blodgett Films

Preparation techniques, evaporation/sputtering, chemical processes,MOCVD,sol-gel etc.,Langmuir-Blodgett(L-B) film,growth techniques,photolithography,properties and applications of thin and L-B films.

C) Liquid crystals

Mesomorphic behaviour,thermotropic liquid crystals,positional order,bond orientational order,nematic and smectic mesophases,smectic – nematic ttransition and clearing temperature-homeotropic,planer and schlieren textures,twisted nematics,chiral nematics,molecular arrangement in smectic A and smectic B phasesopoptical properties of liquid crystals,Dielectric susceptibility and dielectric constants.Lytropic phases and their descriptionof ordering in liquid crystals.

Unit- II ***(15)***

A: Polymeric Materials

Moleculr shape,structure and configuration,crystallinity,stress-strain behaviour,thermal behaviour,polymer types and their applications,conducting and ferro-electric polymers.

B) Ionic Conductors

Types of ionic conductors,mechanism of ionic conduction,interstitial jumps(Frenkel);vacancy mechanism,diffusion superionic conductors;phase transitions and mechanism of conduction in superionic conductors,examples and applications of ionic conductors.

Unit – III: High Tc Materials: (15)

Defect perovskites, high Tc superconductivity in cuprates,preparation and characterization of 1-2-3 and 2-1-4 materials, normal state properties;anisotropy; temperature dependence of electrical resistance; optical phonon modes,superconducting state;heat capacity;coherence length,elastic constants,position lifetimes,microwave absorption –pairing and multigap structure in high Tc materials,applications of high Tc materials.

Unit – IV:
A) Materials for Solid State Devices (15)

Rectifiers,transistors,capacitors-IV-V compounds ,low-dimensional quantum structures;optical properties.

B) Organic Solids, Fullerenes, Molecular Devices .

Conducting organics, organic superconductors, magnetism in organic materials.Fullerenes-dopped, fullerenes as superconductors.
Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches- sensors.
Nonlinear optical materials; nonlinear optical effects, second and third order- molecular hyperpolarisability and second order electric susceptibility, materials for second and third harmonic generation.

References :

1. Solid State Physics, N.W.Ashcroft and N.D.Mermin,Saunders College.
2. Material Science and Engineering,An Introduction,W.D.Callister,Wiley.
3. Principles of the Solid State,H.V.Keer,Wiley Eastern.
4. Materials Science ,J.C.Anerson,K.D.Leaver,J.M.Alexander and R.D.Rawlings.ELBS.
5. Thermotropic Liquid crystals,Ed.,G.W.Gray,John Wiley.
6. Handbook of Liquid Crystals,Kelker and Hatz,Chemie Verlag.

Practical course in Industrial Chemistry

M.Sc. Part-I Sem-I
(Practical I/II)

Physical Chemistry Practicals

1. **Potentiometry.**
   a. To determine normality of each acid in given mixture of strong acid (A) and weak acid (B)
   b. To determine solubility and solubility product of sparingly soluble salt of silver(AgCl, AgBr, AgI)

2. **Conductometry**
   a. To determine normality of acids from mixture of strong acid and weak acid using conductometry.
   b. To determine relative strength of chloroacetic acid ($CH_2ClCOOH$) and acetic aid (CH_3COOH) conductometry.

3. **Colorimetry**
   To verify the Beer – Lambert law for the copper – ammonia comples and to determine unknown copper ion concentration in given solution

4. **Heat of solution**
   To determine heat of solution (ΔH) of sparingly soluble acid (benzoic acid) by solubility measurement.

5. **Thermometry**
   To determine heat of solution (ΔH) for NaCl, Kcl, & $MgCl_2$ in 1 M solution thermometry

Organic Chemistry Practicals

1. **Preparation**
   a. p – bromoacetanilide
   b. Benzene azo β – Napthol
   c. Nerolin.
2. **Estimation**
   a. Ibuprofen
   b. Caffine
   c. Isoniazide

Inorganic Chemistry Practicals

1. Analyse the given sample of **iron ore** & Determine **Silica** –Gravimetrically, Iron-**Volumetrically** and find out their percentages in the given sample.

2. Analyse the given sample of Copper Ferrite ($CuFe_2O_4$) & Determine the amount and Percentage of copper Iodometrically, Iron Volumetrically .

3. Determine the capacity of **cation exchange resin** of given sample of cation exchange resin in terms of milliequivalent/g of dry resin.

4. Determine the capacity of **anion exchange resin** of given sample of anion exchange in terms of milliequivalent/g of dry resin.

5. Prepare **Copper Ferrite ($CuFe_2O_4$)** & Find out percentage practical yield of the Copper Ferrite ($CuFe_2O_4$)

M.Sc. Part-I, Semester – II
(Practical III/IV)

Physical Chemistry Practicals

1. **Phase Rule**
   To construct phase diagram for three component system contain C_2H_5OH, C_6H_6 & H_2O

2. **Colorimetry**
   To determine concentration of ammonia in given unknown solution colorimetry

3. **Potentiometry**
   a. To determine formal redox potential (E_R^0) of Fe^{+3}/Fe^{+2} system potentiometrically.
   b. To determine amount of halide in given mixture of KCl and KBr by using Potentiometry
4. **Solubility.**
   a. To determine solubility of PbI2 in presence of different concentration of KNO_3
   b. To determine solubility of PbI2 in presence of different concentration of KCl
5. **Conductometry.**
   a. To determine solubility of sparingly soluble salt (e.g. PbSO4, AgIO3, Ag2CrO4) conductometry
   b. To verify validity of onsagar equation at low concentration for a 1:1 type electrolyte conductometrically

Organic Chemistry Practicals

1. **Preparation**
    a. p- nitroacetanilide
    b. N-N dimethyl aniline
    c. Aryloxy acetic acid
2. **Estimation.**
    a. Acetyl salicylic acid
    b. Estimation of sulpha Drug from given pharmaceutical tablet

Inorganic Chemistry Practicals

1 Analyse the given sample of zinc ferrite ($ZnFe_2O_4$) & Determine the amount and percentage of
    i) Iron- Volumetrically
    ii) Zinc - complexometrically
in the given sample of zinc-ferrite

2. Determine the influence of surface area on rate of corrosion

3. Determine the influence of time on rate of corrosion

4. Estimate the amount of cadmium and zinc from mixture by anion exchange chromatographic method.
    i) Zinc - complexometrically
    ii) Cadmium - complexometrically.

5. Prepare zinc ferrite & Find out percentage practical yield of the zinc ferrite

6. Prepare Pentathiourea dicuprous nitrate find its percentage purity.

7. To estimate phosphoric acid in cola drink by molybdenum blue method.

M.Sc. Part-II, Semester – III
(Practical V/VI)
Physical Chemistry Practicals

1. **Conductometry**
   Determination of percentage of acetic acid in commercial vinegar solution

2. **Fluorimetry**
   To determine the amount of riboflavin in given B-complex tablet

3. **Latent Heat of fusion**
   To determine the latent heat of fusion of given solid

4. **Polarography**
   To study the effect of Oxygen supporting electrolyte and maximum suppressor and determine the half wave potential of Cd/Zn in given solution by Half wave potential method. Differential method and half wave equation method.

5. **Potentiometry**
   To determine the dissociation constant of dibasic acid by potentiometric method

6. **pH – metry**
   To determine the dissociation constant of dibasic acid pH – metrically.

7. **pH – metry**
   To determine pH value of various buffer using pH meter and determination of dissociation constant of acetic acid.

8. **Spectrophotometry:**
   To determine pK value of phenolphthalein indicator by spectrophotometric method.

9. **Spectrophotometry:**
   To study the stoichiometry and stability of ferric sulphate complex by Job's method and Mole ratio method.

Organic Chemistry Practicals

1. Preparation of p – amino benzoic acid from p – toludine
2. Preparation of NBS (N – bromo Succinamide)
3. Preparation of p – iodo nitrobenzene
4. Estimation of cu from copper fungiside
5. Estimation of Endosulfan

Inorganic Chemistry Practicals

Alloy Analysis

1. **Chrome -steel alloy**

   Analyse the given sample of chrome - steel alloy & determine the percentage of
   i) Chromium ----- Colorimetrically.
   ii) Nickel ----- Gravimetrically.

2. Determine the amount of copper and zinc from given sample of **brass alloy**

   I) Copper, Volumetrically/ Gravimetrically.
   II) Zinc, Gravimetrically

3. **Cement analysis**:

   Analyse the given sample of cement for its following constituents.
   i) SiO_2 -Gravimetrically
   ii) Calcium, Volumetrically
   iii) Iron, Volumetrically
   iv) Magnesium, Complexometrically
   iv) Aluminium, Gravimetrically.

4. Find out the percentage of available chlorine in the given sample of bleaching powder

5. Determine the percentage of calcium present in a given sample of plaster of paris volumetrically.

6. Find out the amount of Iron present in a given sample of sulpha - drug; colorimetrically.

7. Determine the percentage of phosphorus present in terms of $\mathbf{P_2O_5}$ from a given fertilizer sample volumetrically.

M.Sc. Part-II, Semester – IV
(Practical VII/VIII)
Physical Chemistry Practicals

1. **Potentiometry:**
   To determine Solubility of PbI2 with Ag/AgI electrode by using potentiometry.

2. **Potentiometry:**
   To determine the dissociation constant of tribasic acid (CH_3PO_4) potentimetrically

3. **Conductometry:**
   To determine the critical micelle concentration of sodium lauryl sulphate in aqueous solution conduct metrically.

4. **Fluorometry:**
   To estimate the Qunine sulphate in given sample by Flurometry.

5. **pH – metry:**
   To determine hydrolysis constant of aniline hydrochloride by pH metry

6. **pH – metry:**
   To determine isoelectronic point and dissociation constant of amino acod (Glycine) by pH metry

7. **Spectrophotometry:**
   To determine stability constant of Ferric thiocynate complex by Frank Ostwald method spectrophotometrically

8. **Polarography:**
   To determine unknown concentrations of Cd^{+2} ion in given solution by standard addition method

Organic Chemistry Practicals

1. Preparation of benzanilide from bromephenone by use of Beckmann's rearrangement
2. Preparation of p- Bromo anil9ine from acetanilide
3. Estimation of Vit – C
4. Estimation Sulfur from Sulfur Fungiside
5. Preparation of Anthranilic acid

Inorganic Chemistry Practicals

1. Analyse the given sample of Magnalium alloy, determine the percentage of,
   i) Aluminium gravimetrically
   ii) Magnesium complexometrically.

2. Analyse the given sample of pyrolusite ore, determine the percentage of,
   i) Silica gravimetrically.
   ii) Iron volumetrically.
   iii) Manganese volumetrically.

3. Analyse the given sample of Bronze metal alloy, determine the percentage of,
   I) Tin as tin oxide gravimetrically.
   ii) Lead as lead sulfate gravimetrically.
   iii) Copper Iodometrically
   iv) Zinc complexometrically.

4. Find out the amount / percentage of **Iron** per gram of soap sample colorimetrically

5. To prepare **potash alum** & find out the percentage of **Aluminium** in the alum.

OR

6. Find out the percentage of '**Magnesium**' in a given sample of Talcum powder complexometrically.

7. Determine the concentration in mg/lit of sulphate ion in the given sample of water nephelometrically.

1.3 Nature of Question Paper

- The semester examination will be conducted at the end of each term (both theory and practical examination)

- Theory paper will be of 80 marks each and 20 marks for internal evaluation test conducted in the mid of the term. Two practicals will be of 100 marks each.
- Question papers will be set in the view of the entire syllabus and preferably covering each unit of the syllabus.

1.4 Standard by Passing

As per rules and regulation of M.Sc. course.

1.5 Nature of question paper and scheme of marking

Theory questions paper: Maximum marks -80

Total No. of question – 7

All questions carry equal marks.

Question no.1 . Compulsory and objective

Total no. of bits – 16, Total marks – 16 (covers multiple choice, fill in the blanks, definition, true or false)

Q.1. is to be solved in separate answerbook and answers to be written in the space provided in the sheet. This answer sheet is to be collected (taken back) after 30 minutes from commencement of examination.Remaining 6 question are divided into two sections, namely section-I and section – II.

Any four question are to be attempted such that not more than two questions from any of the section. Both section are to be written in the same answerbook.

D) Laboratory Safety Equipments:

Part: I Personal Precautions:

1. All persons must wear safety Goggles at all times.

2. Must wear Lab Aprons/Lab Jacket and proper shoes.

3. Except in emergency, over – hurried activities is forbidden.

4. Fume cupboard must be used whenever necessary.

5. Eating, Drinking and Smoking in the laboratories strictly forbidden.

Part: II: Use of Safety and Emergency Equipments:

1. First aid Kits

2. Sand bucket

3. Fire exextinguishers (dry chemical and carbon dioxide extinguishers)

4. Chemical Storage cabinet with proper ventilation

5. Material Safety Date sheets.

6. Management of Local exhaust systems and fume hoods.

7. Sign in register if using instruments.

Credit System:

Students can earn credit towards their post graduation by the way of credit allotted to the paper or to the course.
Type of credit:

a) Credit by examination

b) Credit by non examination

The student will be admitted and given permission to earn credit of papers from options only on merit basis as limited number of seats are available for these papers. In addition to this students can receive credits by Non – Examination

Mechanism of Credit System:

1. Minimum Credits For M.Sc. course for each semester:

Theory	16
Practical	08
Total	24

2. Total Credit for four semester.

24 x 4	96
Additional Credits By non – examination	4
Total Credit	100

3. One Credit should be of 15 contact hours for each paper 4 x 15 = 60 contact hours
4. Practicals: Maximum 8 credits
   Total contact hours : 120

M.Sc. Part – I

Distribution of Credit:

Organic Chemistry practicals	2 Credit
Inorganic Chemistry practicals	2 Credit
Physical Chemistry practicals	2 Credit
Practicals on Analysis of Industrially important Materials	2 credit

M.Sc. Part – II

Distribution of Credit

Organic Chemistry practicals	2 Credit
Inorganic Chemistry practicals	2 Credit

Physical Chemistry practicals	2 Credit
Project	2 Credit
Total contact hours of practicals (8 x 15)	120
Per Day – 3 contact hours for practical	
Practical 4 days per weeks.	
Contact hours per week	12 hours
Total number of weeks required for completion of practical	10 weeks

Total no. of student for each class 30

Batch of 10 students each

No. of Batches 3 (A, B, C)

Minimum three rotation to be completed for each section.

There shall be a ceiling of 4.0 minimum credit requirements of cumulative grade point averages for continuation of the corresponding semester course.

M. Sc. Industrial Chemistry equivalence of pre revised and revised papers.

Sr. No.	Number and Name of the pre revised Paper	Number and Name of the revised paper	Remarks
01.	IC 101 Introduction to Chemical Engineering-I	IC I Introduction to Chemical Engineering-I	M.Sc.I Semester-I
02.	IC 102 General Chemical Technology-I	IC II General Chemical Technology-I	M.Sc.I Semester-I
03.	IC 103 Selected Topics in Organic Chemistry	IC III Selected Topics in Organic Chemistry	M.Sc.I Semester-I
04.	IC 104 Industrial Management	IC IV Industrial Management	M.Sc.I Semester-I
05.	Practical IC 111 and IC 112	Practical I and Practical II	M.Sc.I Semester-I
06.	IC 201 Introduction to Chemical Engineering-II	IC V Introduction to Chemical Engineering-II	M.Sc.I Semester-II
07.	IC 202 General Chemical Technology-II	IC VI General Chemical Technology-II	M.Sc.I Semester-II
08.	IC 203 Selected Topics Inorganic Chemistry	IC VII Selected Topics in Organic Chemistry	M.Sc.I Semester-II
09.	IC 204 Instrumental Methods of Analysis	IC VIII Instrumental Methods of Analysis	M.Sc.I Semester-II
10.	Practical 211 and Practical 212	Practical III and Practical IV	M.Sc.I Semester-II
11.	IC 301 Organic Chemical Industries-I	IC IX Organic Chemical Industries-I	M.Sc.II Semester-III
12.	IC 302 Inorganic Chemical Industries I	IC X Inorganic Chemical Industries I	M.Sc.II Semester-III
13.	IC 303 Methods of Analysis in Industries	IC XI Methods of Analysis in Industries	M.Sc.II Semester-III
14.	IC 304(A) Pollution Monitoring and	IC XII (A) Pollution Monitoring and Control-	M.Sc.II

	Control I	I	Semester-III
15.	IC 304(B) Advanced Analytical Techniques in Industries	IC XII (B) Advanced Analytical Techniques in Industries	M.Sc.II Semester-III
16.	IC 304 (C) Chemical Analysis in Agro, Food and Pharmaceutical Industries.	IC XII (C) Chemical Analysis in Agro, Food and Pharmaceutical Industries.	M.Sc.II Semester-III
17.	Practical IC 311 and Practical IC 312	Practical V and Practical VI	M.Sc.II Semester-III
18.	IC 401 Organic Chemical Industries II	IC XIII Organic Chemical Industries II	M.Sc.II Semester-IV
19.	IC 402 Inorganic Chemical Industries II	IC XIV Inorganic Chemical Industries II	M.Sc.II Semester-IV
20.	IC 403 Selected Topics in Industrial Chemistry	IC XV Selected Topics in Industrial Chemistry	M.Sc.II Semester-IV
21.	IC 404 (A) Pollution Monitoring and Control-II	IC XVI (A) Pollution Monitoring and Control-II	M.Sc.II Semester-IV
22.	IC 404 (B) Pharmaceutical Chemistry	IC XVI (B) Pharmaceutical Chemistry	M.Sc.II Semester-IV
23.	IC 404 (C) Chemistry of Industrially Important Materials	IC XVI (C) Chemistry of Industrially Important Materials	M.Sc.II Semester-IV
24.	Practical IC 411 and Practical IC 412	Practical VII and Practical VIII	M.Sc.II Semester-IV