

Solapur University, Solapur
School of Chemical Sciences

M.Sc. (Chemistry)(Industrial Chemistry) Syllabus

M.Sc.(Chemistry)Part I syllabus is common to all branches of M. Sc. Course viz M.Sc. (Chemistry)(Polymer Chemistry), M.Sc. (Chemistry)(Industrial Chemistry), M.Sc. (Chemistry)(Organic Chemistry), M.Sc. (Chemistry)(Inorganic Chemistry), M.Sc. (Chemistry)(Physical Chemistry) and M.Sc. (Chemistry)(Analytical Chemistry)

Practical Examination will be of 4 days for each semester

M.Sc. (Chemistry)(Industrial Chemistry) Part II (w.e.f. June 2012)

SEMESTER III

Course Code / Paper No	Paper Name	Marks
INDCH301 Paper IX	Unit operations of chemical engineering	70 Univ Exam + 30 Internal exam
INDCH302 Paper X	Unit processes in chemical technology	70 Univ Exam + 30 Internal exam
INDCH303 Paper XI	Pollution monitoring and control	70 Univ Exam + 30 Internal exam
INDCH304 Paper XII	Advanced topics in industrial chemistry	70 Univ Exam + 30 Internal exam
INDCH305	Practical – V	70 Univ Exam + 30 Internal exam
INDCH306	Practical – VI	70 Univ Exam + 30 Internal exam

SEMESTER IV

Course Code / Paper No	Paper Name	Marks
INDCH401 Paper XIII	Organic chemical industries	70 Univ Exam + 30 Internal exam
INDCH 402 Paper XIV	Inorganic chemical industries	70 Univ Exam + 30 Internal exam
INDCH403 Paper XV	Methods of analysis in industries	70 Univ Exam + 30 Internal exam
INDCH404 Paper XVI	Industrial management	70 Univ Exam + 30 Internal exam
INDCH405	Practical – VII	70 Univ Exam + 30 Internal exam
INDCH406	Practical – VIII + Project/inplant training	30 Univ Exam + 30 Internal Exam + 40 project/inplant training

Practical Examination will at 3 days for each semester

M.Sc. II SEMESTER – III
Paper – INDCH – 301 Unit Operations of Chemical Engineering

Unit 1: Introduction to Unit operations (03)

Unit 2: Evaporation (07)

Types of evaporators, jacketed, horizontal and vertical tube evaporators, force circulation evaporation, entrainment separators, and effect of various parameter, scale formation, multiple effect evaporators.

Unit 3: Distillation (07)

Boiling and Distillation, vapor liquid equilibria, azeotropic mixture, multi component systems, flash distillation, steam distillation, vacuum distillation, extractive distillation, batch and continuous distillation, fractional distillation, equipment and working of rectifiers, use of packed column.

Unit 4: Extraction (06)

Liquid equilibria, extraction with reflux, extraction with agitation, equipment, its use and performance, continuous contact equipment, agitators extractors, packed spray extractors, leaching, flow sheets of solid liquid extraction, continuous leaching, counter current extraction.

Unit 5: Filtration (04)

Theory of filtration, pressure and vacuum filtration, filter aids, principles of cake filtrations, cake filtration parameters, washing filter cake, centrifugal filtration, Nutsch and continuous filters

Unit 6: Crushing, grinding, mixing, size separation and drying (04)

Equipment for crushing, grinding and mixing, drying processes, tray, tunnels, drum and spray driers, equipment for determination of moisture in solids, liquids and gases

Unit 7: Crystallization (06)

Crystallization from aqueous, non-aqueous solutions and melts, factors affecting purity, fractional crystallization, supersaturation, nucleation, crystal growth, factors accelerating growth, separation of crystals, contaminants and their removal, crystal hydrates and solvates, decomposition of crystals, deliquescence and hygroscopicity, efflorescence, dehydration, crystallization equipment

Unit 8: Gaseous systems (04)

Gas adsorption, principles, factors for controlling adsorption of gases, solution of gases, removal of gases from liquids, removal of gases from bulk solids and surfaces, degassing, sublimation, vacuum sublimation and applications

Unit 9: Mechanical Separation and Benefication (07)

Screening sieves, equipment and use, gravity separation in settling process, removal of solid from gases, separation of coarse particle in liquid sedimentation and thickening, centrifugal and settling process, cyclone, hydrocyclone, sludge separation, dust filters, dust precipitators, electrostatic dust precipitators, colloidal particles and their removal, benefication, froth floatation, magnetic separation, scrubbers, chemical process, mud as resources, ion exchange separation, membrane separation, osmosis and reverse osmosis.

Reference Book:

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 industry (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 Principle Vol I II (JW).
6. Prakash G. More, Comprehensive Industrial Chemistry, Pragati prakashan, Meerut (Uttar Pradesh)

INDCH – 302 Unit Processes in Chemical Technology

Unit 1: Introduction to Unit Processes (02)

Unit 2: Nitration: (08)

Introduction, nitrating agents, Aromatic nitration, kinetics and mechanism of aromatic nitration, nitration of paraffinic hydrocarbons, nitrate ester, n-nitro compounds, process equipment for technical nitration, mixed acid for nitration, typical industrial nitration process (nitrobenzene, p-nitroacetanilide and α -nitronaphthalene)

Unit 3: Sulphonation (08)

Introduction, sulphonating agents and their applications; kinetics, mechanism and thermodynamics; desulphonation, working up procedures, industrial equipments and techniques, technical preparation of sulphonates (aliphatic sulphonates and aromatic sulphonates).

Unit 4: Halogenation (08)

Introduction, thermodynamics and kinetics of halogenation, survey of halogenations, chlorination in the presence of catalyst, photohalogenation, manufacturing processes for monochloroacetic acid, chloral, chlorobenzene, and vinyl chloride.

Unit 5: Esterification (08)

Introduction, esterification by organic acid, esterification of carboxylic acid derivative, ester by addition to unsaturated system, manufacture of ethyl acetate, vinyl acetate, cellulose acetate

Unit 6: Polymerization (09)

Introduction, chemistry of polymerization reactions, methods of polymerization, polymerization kinetics, industrial importance polymerization and polymers: phenolic, urea and melamine and alkyd resins, polyamides, polyesters, epoxy resins, polyethylene, polypropylene, vinyl polymers, polystyrene, acrylonitrile polymers.

Unit 7: Oxidation (05)

Introduction, Types of oxidative reactions, Liquid phase oxidation with oxidizing compounds, liquid phase oxidation with oxygen, typical manufacturing processes

Reference Books

1. P.H.Groggins: Unit processes in organic synthesis (MGH)
2. F.A.Henglein: Chemical Technology (Pergamon)
3. M.G.Rao & M. Sittig: Outlines of Chemical Technology (EWP)
4. Clausen, Mattson: Principle of Industrial Chemistry
5. F.A. Lowenheim & M.K. Moran: Industrial Chemicals
6. Kirks & others: Encyclopedia of Chemical Technology
7. Kent: Riegels Industrial Chemistry (N-R)
8. Prakash G. More, Comprehensive Industrial Chemistry, Pragati Prakashan, Meerut (Uttar Pradesh)
9. S.D.Shukla & G.N.Pandey: A text book of Chemical Technology Vol. II
10. J.K.Stille: Industrial Organic Chemistry (PH)
11. Billmeyer: A text book of Polymer Science

INDCH – 303: Pollution Monitoring and Control

Unit 1: Regulatory aspects:

(10)

Industrial emission, 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) Act 1974 its implication application and effectiveness in industrial pollution control, water quality management in India, Indian standards, IS – 2490, IS – 33660, IS – 3307 and IS – 2296 MINAS for sugar industries, distilleries, synthetic fiber industries, oil refineries, pesticide industries and mercury from chloroalkali industry. Air (Prevention and control of pollution) Act 1981, good analytical practices for assessment of pollution, management of regulatory requirements.

Unit 2: Pollution and its measurements:

(10)

Nature of industrial effluents, gaseous and liquid effluents, methods of gas analysis, analysis of CO, SO₂, NO_x, S, Cl₂ in the gaseous effluents. Methods of removal of pollutants from gaseous effluents, particulate matter, particle size analysis. AAS applications process for waste water, particle size analysis in waste water, analysis of waste water the free acids and bases, dissolved organic and inorganic compounds like alkali and alkaline salts, SO_x, PO_x, NO_x. Determination of iron and calcium, suspended solids, total cations and anion, estimation of industrial metals recovery techniques: Organic trace chemicals in waste water, volatile carcinogens matter in waste water, recovery and recycling techniques, biological methods of waste water treatments.

Unit 3: Waste Water Treatment:

(08)

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

Unit 4: Removal of Heavy toxic metals

(08)

Chromium, mercury, lead, cadmium, arsenic, analytical methods of determination of small amounts of metal pollutants, copper recovery, treatment of waste water to remove heavy metals, recovery techniques.

Unit 5: Removal of phenolic residues

(08)

Sources of phenolic residues, analytical methods, treatment by using stream gas stripping ion exchange solvent extraction, oxidation method, microbiology treatment. General nature of organic residue not mentioned so far, role of vapor pressure, solubility, effect of pH on solubility, extractive methods of recovery and recycle. Chemical methods of conversion to less soluble to non toxic or biodegradable and carcinogens, economics of recovery methods, incineration of non recyclable concentrate and residues.

Unit 6: Polymer Recycling

(04)

Environment and polymer industry, recycling of polymer wastes.

Reference Books

1. S P Mahajan: Pollution control in process industry (J W).
2. J R Holmes: Refuse Recycling and recovery(JW)
3. M Sitting: Resources recovery recycling handbook and industrial waste (N D S).
4. J O Niagh: Sulphur in the environment Vol I & II (J W)
5. P S Milor: The industry EPA contribution (MGH)
6. R B Pojasele: Toxic and hazardous waste disposal Vol. I and II(AAS)
7. A K Dey: Environmental chemistry
8. W Handley: Industrial safety handbook.
9. J E Huheey: Inorganic Chemistry (1993)
10. A.C. Stern: Air pollution : Engineering control Vol (IV) A.P.
11. P.N. Cheremsihoff and R.A. Young: Air pollution control and design handbook Vol I and II Dekkar.
12. Liptak: Air pollution
13. Wark & Warner: Air pollution origin and control
14. A.K. De: Environmental chemistry
15. S.M. Khopkar: Environmental pollution analysis
16. R.S. Ramalho: Introduction to waste water treatment process (A.P.0
17. M.J. Hammar: Water and waste water technology (J.W)
18. R. Home: Environmental Chemistry, Wiley.

INDCH304 – Advanced Topics in Industrial Chemistry

Unit 1: Material and Energy Balance (08)

- a) Material Balance – Process classification, choice of the system and basis of calculation, processes with chemical reactions, material balance calculation, 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 2: Equipment Design (07)

- a) Material of Constructions: Mechanical properties, corrosion resistance, plastics, ceramics, metal 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, 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 vapors, gas addition.

Unit 3: Silicon Technology (08)

Preparation and purification of silicon, silicon hydride, silicon carbide, silicon nitride, amorphous and crystalline silicon, applications of silicon.

Unit 4: Electro analytical sensor- Recent trends in sensors technology (08)

Sensors, classification of sensors, electroanalytical sensors, sensors electrode, metal membrane electrode sensors, ionic conductance, thin and thick film sensors, nano sensors, and applications in industries.

Unit 5: Synthesis and Characterization of Materials (08)

Synthesis of solid state materials conventional methods, electro deposition, spray pyrolysis, sol-gel, hydro thermal synthesis, chemical deposition, magnetic sputtering, photo enhance CVD, plasma, CND, LASER CVD, low pressure CVD.

Material characterization: electrical, optical, magnetic and thermal properties

Chemical characterization: crystal growth from vapors, melt and solutions, purification methods spec purity, concept of ultra purity, preparation of ultra pure elements of Ga, In, and Ge for semiconductors.

Unit 6: Nanocrystal Technology (09)

Introduction, growth and nanocrystalline materials, nanocrystals in inorganic matrices, glass matrices, and diffusion control growth, nanocrystals in porous glasses. Semiconductor nanocrystals in ionic crystals, nanocrystals in zeolite, composite semiconductor glass films, inorganic in organics, semiconductor nanocrystals in organic solutions and in polymers, nanocrystals on crystal substrate, self organized growth, synopsis of nanocrystals fabricated by various techniques, special properties and applications of nanocrystalline solids.

Reference books

1. J.E.Huheey: Inorganic chemistry (Harper and row)
2. J.D. Lee: New Concise Inorganic Chemistry (ELDS)
3. F. A. Cotton And J. Wilkinson: Inorganic Chemistry (JW)
4. N. B. Hannay: Solid State Chemistry (PH)
5. Z.Wite, R. Speight: Ultra purity (MDI)
6. F. A. Kroger: Chemistry of Imperfect Crystals
7. H. Goponov: Optical and Electronic Properties of Nanocrystalline Materials
8. A. Arora: Industrial Management of Toxic and Hazardous Chemicals.
9. N N Greenwood: Chemistry of elements
10. D Patranabis – Sensors and Transducers
11. CNR Rao: Solid state chemistry
12. J. Gopal Krishnan and CNR Rao, Material chemistry
13. F.A. Henglein: Chemical Technology (Pergamon)
14. J.M. Coulson, J.F. Richardson,; Chemical Engineering Vol I, II,III (Pergamon)

Practical Course Semester III

INDUSTRIAL INORGANIC CHEMISTRY

1. To determine of capacity of cation exchange resin.
2. To determine of capacity of anion exchange resin.
3. Analysis of commercial caustic soda.
4. Prepare aluminum as 8 – hydroxy quinolate.
5. Preparation of nickel oxide.
6. Estimate the amount of chlorine from bleaching powder.
7. Preparation of potash alum from aluminum metal.
8. To determine the influence of surface on rate of corrosion – Kinetics of corrosion I
9. To determine the influence of surface on rate of corrosion – Kinetics of corrosion II
10. Preparation and Analysis of copper ferrite.

Note: Any other relevant experiments may be added

Reference Books:

Vogel's textbook of Quantitative Inorganic analysis
A.J.E. Welch, Inorganic Preparations, George Allen and Unwin Ltd.
W.G. Palmer, Experimental Inorganic Chemistry, Cambridge Press, 1965.
M.A. Malati Experimental Inorganic /Physical Chemistry, Harvard Publishing
Chichester.

INDUSTRIAL ORGANIC CHEMISTRY

1. Preparation of p-nitroso N N dimethyl aniline.
2. Preparation of benzyl acetate.
3. Preparation of benzanilide from benzophenone. (Beckman Rearrangement)
4. Estimation of sulphur, nitrogen.
5. Preparation of Nitrophenol from Phenol
6. Preparation of Benzyl alcohol and benzoic acid from Benzaldehyde.(Cannizaro Reaction)
7. Preparation of β -hydroxynaphthaldehyde from β -naphthol (Reimer-Tiemann Reaction).

Note: Any other relevant experiments may be added

Reference Books

1. A text book of Practical Organic Chemistry – A. I. Vogel
2. Practical Chemistry – Mann and Saunders.
3. A Handbook of quantitative and qualitative analysis – H. T. Clarke.
Organic Synthesis collective volumes – Gillman and Batt.
4. Laboratory experiments in Organic chemistry-Arun Sethi
5. Practical Organic Chemistry.

Industrial Physical Chemistry

1. To determine the heat of solution of benzoic acid.
2. To determine heat of solution of NaCl, KCl, BaCl₂.
3. Study of effect of ionic strength on the reaction between persulphate and iodide by visual method.
4. Determine the formula of the complex formed between cupric ion and ammonia by distribution method
5. Determine the pK_a values of weak dibasic acid pH metrically.
6. To determine the critical micelle concentration of sodium lauryl sulphate in aqueous solution. Conductometry
7. To determine the equivalent conductance at infinite dilution of strong electrolyte and weak acid by Kohlrausch law and dissociation constant of weak acid. Conductometry
8. Determine the E₀ value of Ag/AgI electrode and the solubility product of PbI₂ potentiometrically.

Note: Any other relevant experiments may be added

Reference Books:

1. Findlay's Practical Physical Chemistry – Revised by J.A. Kitchner (V Edition)
2. Experimental Physical Chemistry – F. Daniels and J. Williams
3. Experimental Physical Chemistry – R.C. Das and B. Behera

M.Sc. II SEMESTER – IV

INDCH-401: Organic Chemical Industries

- Unit 1 Dyes:** (10)
- Classification of dyes according to the mode of applications and according to the chemical constitution
 - Methods of preparation of commercial dyes of different classes with suitable examples, typical manufacturing processes of dyes.
 - Fluorescent brightening agents
 - Dyes industries in India
- Unit 2 Drugs and Pharmaceuticals** (10)
- Classification of drugs based on activity
 - Synthetic procedures for the commercial drugs like antipyretics, antibiotics, analgesics and anticancer drugs.
 - Vitamins: Types of vitamins, synthesis of Vit A and Vit E, Vitamin H
 - Drug and pharmaceutical industries in India
- Unit 3 Agrochemicals:** (08)
- Organo chlorine pesticides: BHC, Aldrin, Dieldrin, Endosulphan,
 - Organo phosphorus pesticides: Malathion, monocrotophos, Dimethoate, chloropyriphos.
 - Carbamates: Carbaryl, Bygon, Ziram, Zineb, Maneb.
 - Insect pheromones and Repellants: Pheromone, general introduction and application in integrated pest management (no synthesis), Repellant: Survey and synthesis of following repellants: N,N Diethyl-3-methyl benzamide, N,N, Diethylenebenzamide, 2-ethyl-1,3, hexanediol, Butopytranexyl, Dimethylcarbamate, Dimethylphthalate
 - Agrochemical industries in India
- Unit 4 Petrochemicals** (08)
- Introduction, Petroleum refining, outline of chemicals derived from methane, ethylene, propylene and butylenes; benzene, toluene and xylene; manufacture of petrochemicals, petrochemical industries in India
- Unit 5 Cane Sugar Based Chemicals:** (08)
- Introduction, Manufacturing processes of Acetic acid, oxalic acid, citric acid, acetic anhydride, furfural from bagasse, anhydrous alcohol, sugar based chemical industries in India
- Unit 6 Paints:** (04)
- Introduction, constitution, preparation and applications, paint industries in India

Reference Books

1. Burger: Medicinal chemistry (I.W.)
2. W.O. Foye: Principles of medicinal chemistry (L.E.)
3. Zechmeister: Progress in chemotherapy (C.H.)
4. Lendicer and Mitscher: The Organic Chemistry of drug synthesis (I.W.)
5. N.N. Melnikov: Chemistry of pesticides (Springer)
6. M.B. Green, G.S. Hartley, T.E. West: Chemicals for crop protection and pest management (Pergamon).
7. R.Cremlyn: Pesticides.
8. K.H. Bechel: Chemistry of pesticides
9. H.B. Scher: Advances in pesticides, formulation technology.
10. Kirk and others: Encyclopedia of chemical technology
11. J.M. Paturan: Byproducts of cane sugar industry (Elsevier)
12. S.D. Shukla and G.N. Pande: A text book of chemical technology Vol II.
13. K. Venkataraman- The chemistry of synthetic dyes Vol. 1-7 (A. P.)
14. Abranart :- Dyes and their intermediates (Pergaman)
15. Prakash G. More, Comprehensive Industrial Chemistry, Pragati Prakashan, Meerut (Uttar Pradesh)
16. Bech :- Fiber reactive dyes (logos press)
17. Frig and David:- Dyes intermediates.
18. Allan:- Colour chemistry
19. Kent:- Riegels industrial chemistry
20. M.Ash and I.Ash Formulary of paints and other coatings.
21. P.H. Groggins: Unit process in organic synthesis (MGT)
22. Kirk R Smith: Biofuels: Air pollution and Health: A Global Review (Kluwer Academic/Plenum publisher
23. Plant oil as fuels- Present state of science and future developments
Edited by N. Martini and J.S. Sebeli Springer Verlag 1998.

INDCH - 402 Inorganic Chemical Industries

Unit 1 Inorganic Chemical Industries in India: (03)

Present situation and perspectives of inorganic chemicals, metallurgy, cement and lime, pigment and glass industries in India.

Unit 2 Metallurgy (10)

Industrial metals to be studied w.r.t. minerals in India, Mineral processing Ellingham diagrams, Manufacture and applications of metal alloys, and salts techniques for using low grade minerals

- a) Iron and steel: Iron, steel alloy, tool steel, stainless steel.
- b) Copper alloys.
- c) Zinc
- d) Titanium
- e) Aluminum
- f) Thorium and rare earth and their salts.

Unit 3 Minerals, mineral based Materials and Building materials (08)

Introduction, cement and lime, alumina and their manufacturing processes.

Unit 4 Special materials for electronic industry (08)

- a) Ferrites and magnetic materials.
- b) Phosphorus for various uses, Luminous paints.
- c) Ceramics for insulators.
- d) High temperature materials.
- e) Alloys and ceramic superconductors.

Unit 5 Inorganic Chemicals: (08)

Manufacturing processes, properties and applications of : sodium dichromate, sodium silicate, sodium thiosulphate, aluminium sulphate, potassium permanganate, magnesia, aluminium chloride, ferrous sulphate, manganese dioxide

Unit 6: Glass (06)

Introduction, physical and chemical properties, characteristics of glass, manufacturing process of glass, some special glasses

Unit 7 Pigments (05)

Introduction, manufacturing processes of zinc oxide and titanium dioxide, properties and application

Reference Books

1. F.A. Henglein: Chemical Technology (Pergamon)
2. R.W. Thomas & P. Farago: Industrial Chemistry (HEB)
3. R.N. Shreve: Chemicals Process Industrial (MGH)
4. Riegel's: Industrial Chemistry (Reinhold)
5. D.S.T: Perspectives in science and technology Vol I & II (Vilas)
6. W.H. Dennis: Foundation of iron and steel metallurgy (Elsevier)
7. Prakash G. More, Comprehensive Industrial Chemistry, Pragati Prakashan, Meerut (Uttar Pradesh)
8. Kirk R Smith: Biofuels: Air pollution and Health: A Global Review (Kluwer Academic/Plenum publisher)
9. Plant oil as fuels- Present state of science and future developments Edited by N. Martini and J.S. Sebeli Springer Verlag 1998.

10. Drydens Outline of Chemical Technology Sittig and Rao
11. Biofuels and industrial products from JaTropa curcas; Ed: G. Gubitz M. Mittelbach.
12. M.Trabi, DbV-Verlag Fur die Technische Universitat Graz, GraZ 1997 ISBN 3-7041-0242-3
13. Industrial Chemistry: Das Vol I and II
14. Industrial Chemistry: B.K. Sharma
15. Lowenheim F A (1994): Modern electroplating III ed. Chapman and Hall, London.
16. Goble D: Principle of Metal surface treatment and protection Permagan Oxford (1973).
17. G A Keinth: Electroplating for engineering A Handbook III ed. Van Nastrad Rernbold Co. London.
18. Lowenheim F A: Modern electroplating electrochemical publication New Jersey.
19. Burke: Progress in Ceramic science volume IV
20. R R Ash: A Formulary of paints and other coating Vol. I
21. W H Dennis: Foundation of Steel and Iron Metallurgy, Elsevier.
22. S D Shukla and G N Pandey: A textbook of chemical technology Vol I

INDCH 403 - Methods of Analysis in Industries

Unit 1 Chemical analysis in Industries: (08)

Role of chemical analysis in process development, quality control, process control at each stage of production by-products, acceptance of raw material, effluent monitoring and control for finding out causes of failure or malfunctioning, non-instrumental and instrumental: optical, electrochemical and thermal methods of analysis

Unit 2 Thermal Methods (10)

- a) TGA, chemical change versus weight loss plots, TGA/DTG analysis, use in characterization of raw materials, minerals, polymers, hydrate analysis.
- b) DTA, exothermic and endothermic chemical and physical changes, DTA profile, applications, DSC and applications.

Unit 3 Gas and Fuel analysis (08)

Orsat apparatus and its use in exhaust gas analysis, determination of calorific value of fuels by bomb calorimeter, Zinker's gas calorimeter for gaseous fuel, ultimate and proximate analysis of coal. GCV and NCV.

Unit 4 Radiochemical Methods: (08)

Nuclear reaction and radiation, measurement of radio-activity, application of radionuclides, scintillation counters, Neutron activation analysis (NAA).

Unit 5 Chemical analysis of surfaces (08)

Ion scattering spectroscopy, secondary ion mass spectrometry, auger emission spectrometry, electron spectroscopy for chemical analysis

Unit 6 Pharmacopoeial analysis of drugs (06)

Introduction, analysis of pharmaceuticals using IP/B.P./U.S.P procedures.

Reference books

1. F.J. Welder: Standard Methods of chemicals analysis Vol III part A and B.
2. H.A. Strobel: Chemical Instrumentation (AW).
3. Willard, Meritt & Dean: Instrumental Methods of analysis (FWAP)
4. F.D. Snell, Encyclopedia of Industrial: Chemical Inorganic analysis Vol. 1 to 20 (J.W.)
5. I.P./B.P and U.S.P. books latest edition
6. Hillebrand, Llundell and Hoffman: Applied inorganic analysis (Interscience)
7. D.K. Chakrabarry: Solid state chemistry.

INDCH – 404 Industrial Management

Unit 1 Environmental Management of Toxic and Hazardous Chemicals (12)

Introduction to toxic and hazardous chemicals, procedure for working with substance that pose flammable or explosive hazards, potentially explosive chemicals, transportation of hazardous chemicals, incineration of hazardous chemicals, identification classification and segregation of industrial toxic chemicals, recovery recycling and reuse of industrially important chemicals, safety concept in industry.

Unit 2 Small Scale Industries, R & D and Technology Transfer (14)

Need and scope of small scale industries, SSI rules and regulation, registration, license, incentives, factory act, Labor Laws, S T and Excise, FDA, Export import regulations, tax benefits.

R & D and Technology Transfer

Role of R & 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 flexibility of design comprises to cope-up for safety and economic in construction and operation.

Unit 3 Quality Control and green chemistry (12)

Role Government standard like ISI, MINAS, Agmark, I.P., B.P., U.S.P., concept of quality and quality control, nature of variability's, preparation of control charts, charts for moving averages, defects and defective, specification and tolerance, sampling, inspection, cost reduction, and quality improvement, experiment, optimization.

Green Chemistry

Introduction, principles of green chemistry and applications, tools of green chemistry, evaluating effects of green chemistry, examples of green chemistry reactions.

Unit 4 Energy Resources and biofuels (10)

Chemicals/Electrochemical and solar energy system, conventional and non-conventional energy resources, biomass and biochemical routes, hydrogen storage

Biofuels

Introduction, types of biofuels (Bioethanol, Biodiesel), raw materials for the synthesis of biofuels, properties of biofuels, biofuels and the environment (Emissions from Biofuels), Biofuels and economy, standard specification of biofuel, Biofuels and its uses. Modification of vegetable oils as biodiesel.

Reference Books:

1. R.R. Mukharjee: Element of Quality Control (Vanled books)
2. Industrial Organisation & Engineering Economics-T.R.Banga
3. R.H. Lonter, N.C. Enlok and H.E. Mottley: Qulaity for profit (IP)
4. W.N. Smith, E.G. Mayer and A.R. Hirsig: Industry R D Managment ch 1, 3, 5, 10, 11, 13, 14, 15, 18 (Marcel Dekker)
5. A.Gerstenfield: Effective management of R & D (AW)
6. N.N Singh: Scientific management of SSI (Lalwani)

7. S.K. Tulsi: Incentives for Small Scale Industries (ESRS)
8. G.D. Sharma: How to start your own SSI (Vision books)
9. Compendium of Policy and Procedure for SSI (Maharashtra Chamber of Commerce)
10. F.A. Henglein: Chemical Safety and Engineering (Pergamon)
11. W. Hammer: Occupational safety management and engineering (PH)
12. W.Handley: Industrial Safety A handbook (MGH)
13. P.T. Aastae and J.C. Werner: Green Chemistry Theory and practical (Oxford Press 1998).

Practical Course Semester IV

Industrial Inorganic Chemistry

1. Estimate the amount of calcium from plaster of paris.
2. Determine the amount of Cobalt in given unknown sample by colorimetric method
3. Determine the amount of Chromium and Nickel from given stainless-steel alloy.
4. Estimate the amount of Iron in given unknown sample by colorimetric method.
5. Preparation of chrome alum.
6. Preparation and Analysis of Zinc ferrite.
7. Analysis of Cement
8. Analysis of Fertilizer

Note: Any other relevant experiments may be added

Reference Books:

1. Vogel's textbook of Quantitative Inorganic analysis
2. A.J.E. Welch, Inorganic Preparations, George Allen and Unwin Ltd.
3. W.G. Palmer, Experimental Inorganic Chemistry, Cambridge Press, 1965.
4. M.A. Malati Experimental Inorganic /Physical Chemistry, Harvard Publishing Chichester.

Industrial Organic Chemistry

1. Preparation of sulphanilic acid.
2. Preparation of p-amino benzoic acid.
3. Preparation of p- nitroaniline from acetanilide.
4. Preparation of phenyl benzoate.
5. Preparation of paracetamol.
6. Pinacole-Pinacolone Rearrangement.
7. Preparation of phthaliamide from phthalic anhydride.

Note: Any other relevant experiments may be added

Reference Books

1. A text book of Practical Organic Chemistry – A. I. Vogel
2. Practical Chemistry – Mann and Saunders.
3. A Handbook of quantitative and qualitative analysis – H. T. Clarke.
4. Organic Synthesis collective volumes – Gillman and Batt.
5. Laboratory experiments in Organic chemistry-Arun Sethi.

Industrial Physical Chemistry

1. Determine the acidic and basic dissociation constant of an amino acid and hence determine the isoelectric point of acid pH metrically.
2. To determine the specific refraction of given mixture of liquid and hence find out unknown concentration of mixture.
3. Investigate the autocatalytic reaction between potassium permanganate and oxalic acid.
4. To determine the latent heat of fusion a given solid naphthalene in toluene
7. To determine the molecular weight and state of benzoic acid in benzene by cryoscopic method.
8. to determine the molecular weight and state of acetic acid in benzene Cryoscopy.
9. Demonstration of major sophisticated instruments (uv-visible, IR, TG-DSC, Brookefield viscometer, VPO etc)

Note: Any other relevant experiments may be added

Reference Books:

1. Findlay's Practical Physical Chemistry – Revised by J.A. Kitchner (V Edition)
2. Experimental Physical Chemistry – F. Daniels and J. Williams
3. Experimental Physical Chemistry – R.C. Das and B. Behera