

SOLAPUR UNIVERSITY, SOLAPUR

CGPA SYLLABUS OF M. Sc. Part-II (Industrial Chemistry)

w.e.f. June 2015

A two-year duration M.Sc. Industrial Chemistry syllabus is prepared by a panel of eminent University professors, scientists and experts from industries. It is designed for the Semester system and this syllabus will be implemented with effect from June 2015 for M.Sc. II after approved by appropriate academic bodies and the University authorities. The syllabus has been prepared taking into consideration the present and near future Needs; SET, NET, UGC guidelines and syllabi of other established Universities.

General Structure of the Course:

The course consists of four semesters spread over two academic years. Each semester has four “theory papers” of 100 marks each (including 30 marks of internal tests). For semester I and II each all four papers are compulsory and for semesters III and IV three papers are compulsory and fourth is elective. There are four practicals in each I and II semesters, where as practicals of M. Sc. II are, spread over Sem.III & IV. Examinations of these practicals will be held at the end of each semester. The distribution of marks is mentioned below.

M Sc Part-I

Theory Paper (Semester I and II)	: 8 x 100	= 800 marks (including 30 marks of internal tests)
Practical (Semester I and II)	: 4 x 50 x 2	= 400 marks
Seminar(Semester I and II)	: 25 x 2	= 50
	Total	= 1250

M Sc Part-II

Theory Paper (Semester III and IV)	: 8x100	= 800 marks (including 30 marks of internal tests)
Practical (Semester III and IV)		= 400 marks
Seminar (Semester III and IV)	: 25 x 2	= 50
	Total	= 1250

Total Marks : 2500

M. Sc. Part-II (Industrial Chemistry)

Semester III

Paper No.	Title of the Paper	Internal Marks	External Marks	Total Marks
301	Unit operations of chemical Engineering	30	70	100
302	Unit processes in Chemical technology	30	70	100
303	Instrumental Analysis	30	70	100
304	A) Advanced Topics in Industrial Chemistry -I OR B) Advanced Topics in Industrial Chemistry-II	30	70	100
305	Practical-V	30	70	100
306	Practical-VI	30	70	100
	Seminar	25		25
	Total	205	420	625

Semester IV

Paper No.	Title of the Paper	Internal Marks	External Marks	Total Marks
401	Chemical Industries-I	30	70	100
402	Pollution Monitoring and Control	30	70	100
403	Nanotechnology and Instrumental Analysis	30	70	100
404	A)Industrial Management and Material Balance OR B) Chemical Industries-II	30	70	100
405	Research Project/Inplant Training & Practical - VII	30	70	100
406	Practical-VIII	30	70	100
	Seminar	25		25
	Total	205	420	625

Nature of Practical Examination

M. Sc. Part-II: Distribution of marks (Practicals):-

Sem. III:	305 (V)	306 (VI)
1. Experiments	60	60
2. Internal Practical Exam.	30	30
3. Oral examination	05	05
4. Journal	05	05
Total	100	100

* Practical Exam will be conducted for 3 days; with 2 experiments each day. (I.e. total 6 Experiments-for 60 + 60 = 120 marks-)

Sem. IV:	405 (VII)	406 (VIII)
1. a) Experiments	60	25
b) Lab Project / Review Article-literature / Industrial Training	--	40
2. Internal Practical examination	30	30
3. Oral examination + Journal	10	05 (of Exp) Total
	100	100

** Practical Exam will be conducted for 3 days; with 2 experiments each day for 2 days. (I.e. total 4 experiments-for 70 marks) and on one day project-defense should be carried out.

Nature of Question Papers

There shall be seven questions out of which the candidate has to solve five questions. Each question will carry 14 marks. Q. NO.1 (Section I) will be compulsory, objective type and will carry 1 mark per sub-question. Out of Q. No. 2 to 4 (Section II) and Q. No. 5 to 7 (Section III) candidate has to solve two questions from each section, total four questions. At least 50% of the questions should be problem oriented rather than descriptive, keeping in view SET, NET, GATE and other competitive examinations. The questions should test the understanding of the candidate rather than memory. The purpose of the exercise should be career oriented to prepare the candidate well for national and international level competition.

Notes:

1. M.Sc. I syllabus is common for Polymer Chemistry, Industrial Chemistry, Organic Chemistry, Physical Chemistry, Analytical Chemistry and Inorganic Chemistry.
2. Each theory course prescribed for M. Sc. should be covered in 60 periods, each of 60 minutes; engaging 4 lectures per course per week. (Including tutorials, seminars etc.)
3. Each practical course will require 6 hr of Laboratory work per week. [i.e. 12 hr for 2 Lab. Courses per week]
4. There shall be 8 students in a batch for M. Sc. Practical Course. (In any case not more than 10 students in a batch).

INDCH – 301 Unit operations of Chemical Engineering

Credits-04

60 hr

Unit I:

A) Heat Exchangers

Introduction; Shell and Tube Heat Exchanger, Shell side and tube side passes ;Classification of Shell and Tube Heat Exchangers-Fixed tube sheet heat exchanger, Fixed tube sheet 1-2 heat exchanger, Internal floating head heat exchanger, U-tube heat Exchanger, Kettle Reboiler.

B) Evaporation

Introduction; Types of evaporators-Jacketed, Horizontal and Vertical tube evaporators, forced Circulation evaporation; Entrainment separators; Effect of various parameters on Evaporation; Multiple effect evaporators and its Economy.

Unit II:

A) Distillation

Introduction; Boiling and Distillation; Vapor liquid equilibria; Azeotropic mixture; Flash/Equilibrium distillation; Steam distillation; Vacuum distillation; Extractive distillation; Batch and Continuous distillation; Equipment and working of Rectifier/Fractionating column-Bubble cap plate, Sieve-plate, Valve plate, Downcomers.

B) Extraction

Introduction; Selection of solvent for Extraction; Extraction with agitation and its Equipments-Mixer Settler, Spray column ,packed column, Sieve column , Rotating disc Contactor, pulse column; Extraction with reflux , Flow sheet of extraction with Reflux (Sulfolane process)

C) Leaching

Introduction; solid liquid leaching- Batch plant for extraction of oil from seed, Bollman extractor, Rotocel extractor; continuous leaching Equipments-Dorr Agitator, Dorr thickener, Continuous counter- current extraction.

Unit III:

A) Filtration

Introduction; Principles of cake filtration ; Types of filtration-Constant rate, Constant pressure filtration; Filter aids; washing filter cake; Filtration Equipment – centrifugal filtration, Rotary drum filter.

B) Crystallization

Introduction; Supersaturation, Methods of supersaturation, The Miers supersaturation theory and its limitation ; Nucleation, Homogeneous Nucleation; crystal growth; Caking of crystal; Crystal hydrates and Solvates; Deliquescence and Hygroscopicity; Efflorescence; crystallization equipment-Agitated tank crystallizer, Swenson -walker crystallizer, vacuum crystallizer, Oslo cooling crystallizer.

Unit IV:

A) Crushing, Grinding, Drying and Mixing

Equipment for crushing-Blake Jaw crusher, Dodge Jaw crusher ,Gyratory crusher;
Equipment for grinding –Hammer mill, Revolving mill, Ball mill ; Equipment for drying
processes-Tray, Tunnels, Drum, Rotary ,and Spray driers, Equipment for mixing
processes-propeller, turbines.

B)Mechanical Separation and Beneficiation

Introduction; Screening sieves- equipment and use, Removal of solid from gases-
Cyclone, Hydrocyclone, Dust filters- electrostatic dust precipitators, colloidal particles
and their removal- scrubbers.

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

Credits-04

60hr

Unit I: Nitration

15hr

Introduction; Nitrating agents, Aromatic nitration, Thermodynamics of Nitrations; Heat of Nitration ; Process equipment for technical nitration; Mixed acid for nitration- Acid processing, Mixed acid composition, D.V.S. Calculation, Relation between D.V.S. and Stability of Nitrator Charge ; Typical industrial Nitration process (Nitrobenzene, and α -Nitronaphthalene)

Unit II: Sulphonation

15hr

Introduction; Sulphonating agents and their applications; Thermodynamics of sulfonation ; The Desulphonation Reaction – General consideration, Separation of isomers, Raw material and waste Recovery ; working -up procedures; Industrial equipments and Techniques-Material of construction, Commercial Sulfonation Methods; Technical preparation of Sulfonates - Aromatic Sulfonates (The mono sulfonation of Benzene, Anthraquinome -1- Sulfonates).

Unit III: A) Halogenation

15hr

Introduction; Chlorination of cycloparaffins; Preparation of Ethylene dichloride ; Design and construction of Equipment for Halogenation ; Technical Halogenations - Manufacturing processes for monochloroacetic acid, Chloral, Monochlorobenzene, and Vinyl chloride (Ethylene and Acetylene).

Unit III: B) Esterification

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 IV: A) Polymerization

15hr

Introduction; Chemistry of polymerization reactions; Methods of polymerization, polymerization kinetics; Industrially importance polymerization and polymers: Phenolic, urea and melamine and alkyl resins, Polyamides, Polyesters, Epoxy resins, Polyethylene, Polypropylene, Vinyl polymers, Polystyrene, Acrylonitrile polymers.

Unit IV: B) Oxidation

Introduction; Types of oxidative reactions; Liquid phase oxidation with oxygen-Acetaldehyde to Acetic acid, Vapour phase oxidation aliphatic compound- oxidation of Methanol.

Reference Books

1. P.H.Groggins: Unit processes in organic synthesis (MGH)
2. F.A.Henglein: Chemical Technology (Perga mon)
3. M.G.Rao & M. Sitting: 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. Billmayer: A text book of Polymer Science

INDCH-303 Instrumental Analysis

Credits-04

60 hr

Unit I:

A) IR Spectroscopy

15hr

Only Review of vibrational frequencies of alkanes; alkenes; alkynes; aromatic compounds; alcohols; ethers; phenols and amines, carbonyl compounds such as ketones; aldehydes; esters; amides; acids; anhydrides; Carboxylic acid and conjugated carbonyl compounds etc; Finger print Region.

B) Mass spectrometry

Theory; instrumentation- various methods of ionization (SIMS, FAB, MALDI, californium plasma); different detectors [magnetic analyzer, ion cyclotron analyzer, quadrupole mass filter, time of flight (TOF)]. Importance of HRMS; Types of ion produced-molecular ion, base ion/peak, heavier isotope peak; Fragmentation – A general View, Gas chromatography-mass spectrophotometer.

Unit II:

¹H NMR

15hr

Brief Review of basic principle, Fourier Transform technique, relaxation processes

;Chemical Shift; Factors affecting chemical shifts (inductive, resonance and anisotropic effect with examples), chemical shift of different types of protons (alkane, alkene, alkyne and allene), aromatic protons and effect of substituent, different types of spin coupling; First order analysis of spectra, Spin coupling- different spin systems (AB, AM, AX, ABX/AMX spin systems with examples), Factors affecting coupling constants (dihedral angle, Karplus equation-graph, electronegativity, bond order, hybridization, bond angle with examples), non equivalence due to restricted rotations, rate processes. Effect of high field NMR for simplification of spectra; Shift reagents; Spin decoupling and Nuclear Overhauser effect with examples; Resonance with other nuclei-Fluorine and Phosphorus.

Unit III:

A) ^{13}C NMR

15hr

off-resonance technique; Factors affecting chemical shifts, analogy with ^1H NMR; Effect of substituents on chemical shifts; Different types of carbons (alkene, alkyne and allene), Chemical shift of aromatic carbons, carbonyl, nitrile, oxime carbons. Calculations of chemical shift of Alkane only.

B) Two dimensional (2D)

Principle and pulse technique, DEPT with 3 different angles, ^1H - ^1H COSY, ^1H - ^{13}C COSY (HETCOR, HMQC, HMBC, HSQC), interpretation of 2D spectra and examples.

Simpler structure elucidation with IR, ^1H NMR

Unit IV:

A) Electro Analytical Techniques/Sensor

15hr

Sensors; Electro analytical sensors, Sensors electrode- Metal electrode sensors, Membrane electrode- pH Sensor, Liquid membrane, Crystalline membrane, Gas sensing, Biomembrane/Enzyme electrode; Ionic conductors- Zircona, Tin oxide, Zinc oxide, Titania

B) Nephelometry and Turbidometry

Introduction; Principle; Turbidimetry and Nephelometry- Instrumentation and Applications.

Books Recommended:

1. Introduction to Spectroscopy – D. L. Pavia, G.M. Lampman, G. S. Kriz, 3rd Ed. (Harcourt college publishers).
2. Spectrometric identification of organic compounds R. M. Silverstein, F. X. Webster, 6th Ed. John Wiley and Sons.
3. Spectroscopic methods in organic chemistry – D. H. Williams and I. Flemming Mc Graw Hill.
4. Absorption spectroscopy of organic molecules – V. M. Parikh
5. Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer- Verlag (1986).
6. One and Two dimensional NMR Spectroscopy- - Atta-Ur-Rehman, Elsevier (1989).
7. Organic structure Analysis- Phillip Crews, Rodriguez, Jaspars, Oxford University Press (1998).
8. Organic structural spectroscopy- Joseph B. Lambert, Shurvell, Lightner, Cooks, Prentice-Hall (1998).
9. Organic structures from spectra- Field L. D., Kalman J.R. and Sternhell S. 4th Ed. John Wiley and sons Ltd.
10. NMR spectroscopy of Organic compounds. Jackmann and Sternhell S.
11. Spectroscopy: Donald L. Pavia, Gary M. Lampman.

INDCH 304A – Advanced Topics in Industrial Chemistry-I

Credits-04

60 hr

Unit I:

15hr

A) Analysis of Fertilizers - Sampling, sample preparation. Analysis of nitrogen, phosphorous and potassium. Nitrogen- urea nitrogen, Kjeldahl nitrogen method, Ammonia nitrogen; phosphorous- Total phosphorous. Alkalimetric ammonium molybdophosphate method, potassium - potassium by sodium tetraphenyl borate method.

B) Fuel analysis: Introduction to Solid, liquid and Gaseous fuel ; Analysis of coal - Ultimate and Proximate analysis ; Analysis of Liquid fuel-Aniline point, Flash point and Fire point; Octane number of Liquid; Determination of Calorific value of Fuel by bomb Calorimeter; Orsat apparatus and its use in exhaust gas analysis. Lubricant analysis-cloud point and pour point, carbon residue, viscosity by Redwood method

Unit II:

A) Drug

15hr

Introduction; Pharmacokinetics-absorption, distribution, metabolism, excretion; Pharmacodynamics-receptor, protein receptor, DNA as receptor; Concept of prodrug; Pharmacophore; LD₅₀ and ED₅₀; Structure activity relationship in drug- elucidation with sulphadiazine; Synthesis of drug- chloroquine, Salbutamol, Ibuprofen, methyldopa, Alprazolam, ciprofloxacin.

Unit III:

Formulation of Drug

15hr

Introduction; Need for the conversion of drug into medicine; Additives and their role; Classification of drug –Route-wise dosage forms, Solid dosage forms; solid dosage forms- Tablets, Capsule; liquid dosage forms-parenterals; liquid oral dosage forms- Syrups, suspension; Semi –solid dosage forms – ointments, creams.

Unit-IV:

15hr

A) Pharmacopoeial analysis of drugs

Introduction, Assay of drug-Analgesic drug; Analysis of pharmaceuticals using IP/B.P./U.S.P procedures.

B) Green Chemistry

Introduction, principles of green chemistry; examples of green chemistry reactions.

Books Recommended:

1. P.T. Aastae and J.C. Werner: Green Chemistry Theory and practical (Oxford Press 1998).
2. F.J. Welder: Standard Methods of chemicals analysis Vol III part A and B.
3. I.P./B.P and U.S.P. books latest edition
4. Burger: Medicinal chemistry (I.W.)
5. W.O. Foye: Principles of medicinal chemistry (L.E.)
6. Zechmeister: Progress in chemotherapy (C.H.)
7. Lendicer and Mitscher: The Organic Chemistry of drug synthesis

INDCH 304B – Advanced Topics in Industrial Chemistry-II

Credits-04

60 hr

UNIT-I

15hr

Name Reactions

Arndt-Eistert, Hunsdiecker reaction, Baeyer-Villiger, Gabriel synthesis, Michael, Darzens, Prins, Henry, Hoffmann–Löffler–Freitag, Vilsmeier, Ene, Mannich, Strecker amino acid synthesis. Bamford-Stevens, Baylis-Hillmann, Corey-Fuchs Reaction, Julia Olefination, Mukaiyama aldol, Mitsunobu, Peterson olefination, Corey-Winter olefination, Shapiro, Ritter, Stille, Heck, Sonogashira, Suzuki, Duff, Chugaev, Petasis,. Ring closing metathesis (Grubb's metathesis), Aldol-Tishchenko reaction (Evans-Tishchenko reaction), Ugi, Passerini, Biginelli, Hantzsch condensation.

Unit-II

15hr

Mossbauer spectroscopy- Theory, isomer shift and quadrupole interaction, spectra of iron and tin compounds. Mossbauer spectrophotometer, applications. [$\text{Fe}_3(\text{CO})_{12}$, Prussian blue, oxyhemecrythrin, tin halides, hexacyano ferrates, nitroprussides]

Nuclear Quadrupole Resonance Spectroscopy- Introduction, effect of magnetic field on the spectra, relation between electric field gradient and structure applications of NQR.

Unit-III

15hr

Standardization and quality control of different dosage form

Brief introduction to different dosage forms with the IP requirements Analytical methods for the following- Tablets (aspirin) additives used in tablet manufacture, capsules (Rifampicin) Powders (Sodium benzoate), Solutions (saline NaCl) Suspensions (barium sulphate –limit test for impurity) Mouthwashes (Ointments (salicylic acid) and creams (Dimethicone by IR) Injections (Mannitol) , ophthalmic preparations (sulphacteamine), Aerosols (salbutamol), Blood products and reporting protocols.

Unit-I:

Theory of Volumetric and Gravimetric Analysis:

15hr

Standard solutions Indicators, theory of indicators , types of titrations, Acid , base , precipitation, Redox and complexometric titrations, Acid–base titrations in nonaqueous media , solvent characterisation , living effect , applications of non – aqueous titrations , MnO_2 in pyrolusite, $\text{Na}_2\text{CO}_3 + \text{NaHCO}_3$ and $\text{NaOH} + \text{Na}_2\text{CO}_3$ Mixture analysis , Gravimetric Analysis purity of the precipitate – Co precipitation's and post Post precipitations , precipitation from homogenous solution , organic precipitation

Reference Books

1. Fundamentals of Molecular Spectroscopy. By C N Banwell.
2. Electron Spin Resonance. By Assculiein.
3. Molecular Spectroscopy. By G M Barrow
4. Molecular Spectroscopy. By I N Levine. Wiley Interscience.
5. Basic Concept in Analytical chemistry, by S.M. Khopkar.
6. Spectroscopy (Atomic and Molecular) by G R Chatwal and S K Anand
7. Instrumental methods of chemical analysis by H. Kaur
8. F. J. Welcher: Standard methods of Chemical analysis, 6th Ed. Vol. I and II(D. Van Nostard Comp.)
9. I. M. Kolthoff: Treatise on Analytical Chemistry Vol. I & II
10. F. D. Snell: Encyclopedia of industrial Chemical Analysis Vol. 1 to 20 (John Wiley)
11. Riech: Outline of Indutrial Chemistry.
12. K. H. Buchel: Chemistry of Pesticides (John Wiley)

INDCH - 401 Chemical Industries

Credits-04

60 hr

Unit I: A)

A) Metallurgy Industry

15hr

Extraction and applications of metal alloys

a) Iron and steel: Iron, steel alloy, tool steel, stainless steel.

b) Aluminum

B) Cement Industry

Introduction; Classification and Manufacturing processes of Cement and Lime; Setting and Hardening process.

C) Glass Industry

Introduction; Physical and Chemical properties; Characteristics of glass; Raw material Manufacturing process of glass; Ceramic- Raw material, Manufacturing process of White ware, Glazing.

Unit II:

A) Paints and Pigments Industries

15hr

Paints- Introduction; Classification of paints; Constituents of paints; Formulation of paints; Mixing of paints; Manufacturing processes of paints ; Failure of paints; Varnishes, Enamels, Emulsion paints- Constituents.

Pigment- Manufacturing processes of zinc oxide and titanium dioxide, properties and application

Special paints- Luminescents paints, Heat resistant paints, cellulose paints.

B) Dyes

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

Unit III:

Agrochemicals:

15hr

a) Organo chlorine pesticides: BHC, Aldrin, Dieldrin, Endosulphan,

b) Organo phosphorus pesticides: Malathion, monocrotophos, Dimethoate, chloropyriphos.

c) Carbamates: Carbaryl, Bygon, Ziram, Zineb, Maneb.

d) 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

Unit IV:

Petrochemicals

15hr

Crude oil, Natural gas, Petroleum hydrocarbons- Types and source of crude oil; Refining various petroleum fractions- Thermal cracking, Recycle cracking, Thermal cracking of fuel ; outline of chemicals derived from natural gases/ paraffin hydrocarbon-Ethylene, Propylene Butylenes, Benzene, Toluene.

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.

INDCH – 402: Pollution Monitoring and Control

Credits-04

60 hr

Unit I:

15hr

A) Regulatory aspects

Environmental legislation -Water (prevention and control of pollution) Act 1974, Air (Prevention and control of pollution) Act 1981, its implication application and effectiveness in industrial pollution control, water quality management in India; Indian standards- IS – 2490, IS – 3360, IS – 3307 and IS – 2296; MINAS for- Sugar industries, Distilleries, Synthetic fiber industries, Oil refineries.

B) Removal of phenolic residues

Sources of phenolic residues; Analytical treatment/Removal methods- Stream gas Stripping, Ion exchange, Solvent extraction, Oxidation method, Biological treatment.

Unit I:

15hr

A) Waste Water Treatment

Treatment of waste water:

b) Primary treatment-Sedimentation, Flocculation.

c) Secondary treatment- Tricking filters, Activated sludge process, oxidation pond .

d) Tertiary treatment- Ion-exchange, Electrodialysis, and Reverse osmosis.

e) Advanced waste water treatment-Nitrogen and Phosphorus removal.

B) Air Pollution and its measurements

Nature of Industrial effluents- Gaseous and liquid effluents; Methods of gas analysis-Analysis of CO, SO₂, NO_x, H₂S, in the gaseous effluents. Methods of removal of pollutants from gaseous effluents- Particulate matter, Particle size analysis;

Unit III:

15hr

A) Removal of Heavy toxic metals

Chromium-control method; Removal method- Reduction Precipitation ,ion Exchange, Reverse osmosis, Lime coagulation and absorption; Mercury- Measurement of mercury,Removal of mercury from Gaseous streams,Removal of mercury from liquid streams, Ion exchange method

B) Polymer Recycling

Polymer recycling technologies- Melt processing, Chemical Conversation.

Unit IV:

15hr

A) Soil Pollution and analysis

Concept of Soil pollution; Sources, types of pollutants and pollution;

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

B)Water Pollution and Analysis

Analysis of process waste water - free acids and bases, dissolved oxygen, inorganic compounds – chloride, fluoride,cyanide, SO_x, PO_x, NO_x , suspended solids.

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)

INDCH-403 Nanotechnology and Instrumental Analysis

Credits-04

60 hr

Unit I:

A) Nanoscience and Nanocrystal Technology **15hr**

Introduction, Possible application of nanotechnology for Nano device-Nano sensor (only introductory).

B) Synthesis and growth technique of Materials/Nanomaterial

Synthesis of solid state materials conventional methods- Electrodeposition, Spray Pyrolysis, Sol-gel, Hydrothermal synthesis, Chemical bath deposition, Chemical Vapor deposition CVD, Photo assisted CVD, plasma assisted CVD, Magnetron Sputtering; Crystal growth from vapors, melt and solutions; Preparation of ultra pure elements of Gallium, Indium and Germanium for semiconductors- Czochralski method. Zone refining ; Preparation and purification of silicon,; Amorphous and Crystalline silicon. Preparation of carbon Nanotube by CVD.

Unit II:

Optical and electron microscopy: **15hr**

SEM, TEM, AFM, and XPS Instrumentation and application.

Unit III:

Thermal Methods **15hr**

Introduction to TGA; Instrumentation ;Chemical change versus weight loss plots, TGA analysis, Use in characterization of raw materials, minerals, polymers, hydrate analysis.

Introduction to DTA; Instrumentation; Exothermic and Endothermic chemical and physical changes; DTA profile; Applications,

Introduction to DSC; Instrumentation; Applications.

Unit IV:

X-Ray Diffraction **15hr**

Methods of production of x-rays; Properties of x-rays; Diffraction of x-rays; Bragg's Law; lattice and powder diffraction methods; Small angle scattering of x-ray by Sample; Analysis of molecular structure by XRD; Determination of crystallinity; Size and orientation of Crystallites.

Reference Books

1. Z. Wite, R. Speight: Ultra purity (MDI)
2. F. A. Kroger: Chemistry of Imperfect Crystals
3. H. Gopanov: Optical and Electronic Properties of Nanocrystalline Materials
4. F.J. Welder: Standard Methods of chemicals analysis Vol III part A and B.
5. H.A. Strobel: Chemical Instrumentation (AW).
6. Willard, Meritt & Dean: Instrumental Methods of analysis (FWAP)
7. F.D. Snell, Encyclopedia of Industrial: Chemical Inorganic analysis Vol.
1 to 20 (J.W.)
8. Hillebrand, Llundell and Hoffman: Applied inorganic analysis
(Interscience)
9. D.K. Chakrabarry: Solid state chemistry.

INDCH – 404A Industrial Management and Material Balance

Credits-04

60 hr

Unit I

A) Environmental Management of Toxic and Hazardous Chemicals 15hr

Classification and segregation of Industrial chemicals Potentially explosive chemicals; Incompatible chemical; Pyrophoric chemical; Transportation of hazardous chemicals; Incineration of hazardous chemicals; Safety concept in Industry.

B) Small Scale Industries, R & D and Technology Transfer

Need and scope of Small Scale Industries, SSI registration, license, Incentives-Financial and Non-Financial; Indian factory act-1948; FDA; Export –Import regulations.

Unit II:

A) R & D and Technology Transfer 15hr

Role of R & D; University-Industry interface; Patents; Technology transfer,

B) Pilot Plant Operation and Scale up

Pilot Plant- Introduction, Typical Research program undertaken to avoid risk.

C) Quality Control

Concept of quality control ;Role of Quality Control ;Government Standards - ISI, MINAS, Agmark, I.P., B.P., U.S.P; Control charts-Types of control chart, Preparation of Control charts - X-Bar Chart, R-Chart, p-Chart, C-chart; Application of Control chart, Sampling ,Inspection.

Unit III:

A) Material Balance 15hr

Material Balance – Process classification; Integral Balances on Batch Processes; Material Balance Calculations- Flow Chart, Flow Chart Scaling and Basis of Calculation; Balances on multiple unit processes; Recycle and Bypass.

B) Energy Balance

Forms of energy; Kinetic and Potential energy; Energy Balances on closed systems; Energy Balances on open systems at steady state- Flow Work and Shaft Work.

Unit IV:

A) Material of Construction for Designing Equipment 15hr

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) Chemical reactors

Classification of chemical reactors

C)Energy Resources

Introduction to Conventional and Nonconventional energy resources; Fuel Cell-Hydrogen-oxygen fuel cell, Construction and Working.

D) Biofuels

Introduction; Types of Biofuels -Bioethanol, Biodiesel, Raw materials for the Synthesis of Biofuels; Manufacturing process of Bioethanol from molasses; Manufacturing process of Biodiesel ; Biofuels and economy.

Reference Books:

1. R.R. Mukharjee: Element of Quality Control (Vanled books)
2. Industrial Organization & Engineering Economics-T.R.Banga
3. R.H. Lonter, N.C. Enlok and H.E. Mottley: Quality for profit (IP)
4. W.N. Smith, E.G. Mayer and A.R. Hirsig: Industry R D Management 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. Kirk R Smith: Biofuels: Air pollution and Health: A Global Review (Kluwer Academic/Plenum publisher)

INDCH – 404B Chemical Industries-II

Credits-04

60 hr

Unit I:

15hr

Phosphorus industries: Calcium phosphate, manufacture of phosphoric acid, single and triple super phosphate, baking powder and DAP.

Sulphur and Sulphuric acid: Mining and manufacture of sulphur and manufacture of sulphuric acid by contact process.

Nitrogen Industries: Manufacture of Urea, calcium cyanamide, ammonium nitrate, nitric acid.

Unit II:

15hr

Dairy Chemistry: Milk and milk products, composition and structure of milk, milk proteins, enzymes, vitamins, minerals, density and viscosity of milk, effect of heat on milk, milk processing, basic milk categories, butter, ghee and clarified butter.

Leather Chemistry: Introduction, constituents of animal skin, manufacture and preparation of hides, cleaning, soaking, liming and degreasing, finishing and sharing, tanning; leather, vegetable, chrome, tanning effluents; pollution and control.

Unit – III

15 Hrs

Food Chemistry; Classification, chemical composition and nutritional value of common food stuffs, properties of foods, food preservation and processing, food deterioration, methods of preservation and processing by heat, cold, chill storage, deep freezing, drying, concentration, fermentation, and radiation. Food quality; sensory evaluation, objective methods, non-nutritional constituents and food safety.

Unit – IV

15 Hrs

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

Introduction, Electrodeposition, electroplating (Factors affecting, requirements and applications), hot dipping, metal cladding, immersion plating, metal spraying, vapour deposition and chemical and organic coating.

Chloralkali Industries: Soda Ash, Caustic Soda, Chlorine

Recommended Books

1. Lowenheim F A (1974) Modern Electroplating III Ed Chapman & Hall, Landon.
2. Gable, D: Principal of metal Treatment and protection. Pergamon, 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
6. R.R.Iash: afromulary of paints and other coating Vol. I
7. J.D. Gilchrist: Extraction Metallurgy (Pergamon)
8. S.D. Shukla & G N Pandey: A text book of chemical technology Vol. 1
9. F A. Henglein: Chemical Technology (Pergamon)
10. L. W. Aurand, A. E. Woods, Food Chemistry, AVI Publishing Inc.
11. L. H. Mayer, Food Chemistry, Affiliated East-West Press Ltd., New Delhi.
12. N. Shakuntala Manay, M. Shadakhsara Swamy, Foods-Facts and Principles.
13. John M. deMan, Principles of Food Chemistry.

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.
- 11 To estimate phosphoric acid in cola drink by molybdenum blue method.
12. Estimation of Na, K and Li individually by Flame Photometry.
13. Determination of amount of Zinc from the given sample solution by Nephelometric/Turbidimetric titration using standard solution of Ba (NO₃)₂ or Pb (NO₃)₂.
- 14, Estimation of purity of a given azo dye by colorometry.
15. To estimate the amount of D-Glucose in given solution polarimetrically.

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).
8. Interpretation of IR spectrum with reference to stretching vibration $C=N$, $C=O$, $N-H$, $M-O$
9. Interpretation of NMR spectrum with reference to calculation of chemical shifts and general comments.
10. Preparation of p- Nitrobenzene by Sandmeyer reaction.
11. Preparation of p- chloro nitrobenzene by Sandmeyer 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.
9. To determine pK value of methyl red indicator at room temperature Spectrophotometrically.
10. To determine half wave potential of a given ion using half height method, differential method and wave equation method. (Polarography)

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

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
9. X-ray powder diffraction analysis of cubic compound
10. Determination of moisture content in food/drug sample by Karl Fisher reagents.
11. Estimation of various transition elements like Zn/Ni/Co/Cd/Al from various commercial samples by complexometric titrations on potentiometer by using mercury electrode
12. Analysis of iodized table salt.

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.
8. Preparation, purification and assay of aspirin.
9. Estimation of sodium benzoate/sodium metabisulphite. boric acid and salicylic acid in food.
10. Isolation of casein from milk.

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
5. To determine the molecular weight and state of benzoic acid in benzene by cryoscopic method.
6. to determine the molecular weight and state of acetic acid in benzene
Cryoscopy.
7. Demonstration of major sophisticated instruments (uv-visible, IR, TG-DSC, Brookefield viscometer, VPO etc)
8. To determine stoichiometry & stability constant of ferric Sulphosalicylic acid/ salicylic acid complex by Job's Method and mole ratio method spectrophotometrically.
9. To determine equilibrium constant of reaction $KI + I_2 \rightleftharpoons KI_3$
Spectrophotometrically.
10. Determination of unknown concentration of Cd^{+2} / Zn^{+2} ion in the given solution.
by standard addition method.(Polarography)
11. Estimation of various transition elements like Zn/Ni/Co/Cd/Al from various commercial samples by complexometric titrations on potentiometer by using mercury electrode
12. Analysis of malathion by colorometry.

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