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**NORTH MAHARASHTRA UNIVERSITY  
JALGAON - 425 001**

**SYLLABUS**

**FOR**

**M.Sc. [Industrial Chemistry]**

**(From June 1995)**

**Semester I & II**

**DEPARTMENT OF CHEMICAL SCIENCES**

M.Sc. INDUSTRIAL CHEMISTRY

FIRST YEAR

INDCH 101 INTRODUCTION TO POLYMERS

INDCH-102 APPLIED CHEMISTRY

INDCH-103 CHEMICAL PROCESSES TECHNOLOGY

INDCH 104 ANALYTICAL METHODS AND USE OF COMPUTERS IN  
CHEMISTRY

INDCH 105 LABORATORY COURSE-I

SEMESTER - II

INDCH 201 CHEMICAL PROCESS CALCULATIONS

INDCH 202 CHEMICAL ENGINEERING THERMODYNAMICS

INDCH 203 ORGANIC REACTIONS AND SYNTHESIS

INDCH 204 INSTRUMENTAL METHODS OF ANALYSIS

INDCH 205 LABORATORY COURSE-II

## INDCH - 101 : INTRODUCTION TO POLYMERS

### 1. Basic Concepts and Polymer Nomenclature :

Concept of functionality and reactivity, Degree of polymerisation, Homopolymers, Co-polymers, Linear polymers, Branched polymers, Cross linked or three dimensional polymers, Block co-polymers.

### 2. Classification of Polymers :

Organic polymers, Elemento-organic polymers, Regular and irregular polymers, Chemical Heterogeneity, Polar and non-polar polymers

Introduction to Elastics (Thermoplastics and Thermosets), Fibres, foams, adhesives and elastomers, Natural Polymers, Stress-strain curves.

### 3. Polymerization Phenomenon :

Types of Polymerisation, Chain (Addition) Polymerisation, Step (Condensation) Polymerisation, oxidative coupling.

4. (a) Chain Polymerisation : Radical Polymerisation and ionic polymerisation, basic concepts of Cationic and Anionic methods of polymerisation, Initiation, propagation and termination, living polymers.

Methods of initiation : Thermal decomposition of initiators, azobisisobutyronitrile initiation, Photochemical initiation, Initiation of benzoyl peroxide, thermal initiation, Electroionisation and plasma, initiation using special initiators, determination of efficiency of initiation.

Mechanism of Termination : Inhibitions, Retardation and termination by chain transfer.

(b) Step (Condensation) polymerisation: Degree of polymerisation, polydispersity, Comparison of Chain and Step polymerisation.

5. Ring opening Polymerisation : Polymerisation mechanism of cyclic esters, cyclic amides, N-carboxy- and amino acid anhydrides, cyclosiloxanes.

6. Methods of Polymerisation : Solution polymerisation, Bulk polymerisation, Emulsion polymerisation, Suspension polymerisation, Interfacial polymerisation.

7. Polymer Degradation : Thermal, mechanical, photochemical and chemical.

8. Polymer alloys and blends

## BOOKS RECOMMENDED :

1. Physical Chemistry of Polymers - A.Tager, Mir Pub. Moscow
2. Principles of Polymer Chemistry - P.J.Floory
3. Principles of Polymerisation - G.Odian, Wiley Inter-Sci.
4. Text Book of Polymer Science - F.W.Billmeyer, Wiley Inter-Sci.
5. Polymer Science & Materials - A.V.Tobolsky

## INDCH-102 APPLIED CHEMISTRY

- (1) Water Treatment : Soft water, hard water, methods of softening of hard water, lime-soda, zeolite and ion exchange processes. Calculation of softening reagents. Estimation of hardness of water - EDTA and soap titration method. Characteristics of boiler feed water and boiler troubles.
- (2) Fuels : Fuels and their classifications, calorific value, types of coal and its analysis, preparation and properties of metallurgical coke, classification origin and refining of petroleum, methods of cracking, synthetic gasoline, purification of gasoline, knocking, octane number, cetane number. Natural gas, coal gas, producer gas water gas. Simple problems based on calorific value and combustion calculations.
- (3) Synthetic Fibers : Classification, types of polymerisation, classification of plastics, constituents of plastics, Fabrication of plastics, Engineering properties and uses of plastics, manufacture, properties and uses of plastics, Manufacture, properties and uses of thermoplastics like polyethylene, polystyrene, and thermosetting resins like urea-formaldehyde, phenol-formaldehyde. Common types of synthetic rubber like neoprene, Thiokol, Silicone, polyurethane, industrial uses of rubber recovery of waste rubber.
- (4) Lubricants : Mechanism of lubrication, classification, properties, testing and selection of lubricants.
- (5) Refractories : Definition, Criteria of good refractory, classification, properties, conditions which lead to failure of refractories and testing of refractories, manufacture, properties and uses of common refractories.
- (6) Corrosion : Electrochemical corrosion, factors affecting the rate of corrosion, different types of corrosion, Metallic, inorganic and organic coating for corrosion protection.
- (7) Environmental Pollution :
  - i. Air pollution : Introduction, environmental segments, composition of the atmosphere, atmospheric structure, classification of air pollutants and their effects, control of air pollution, techniques employed for the control of air pollution.

- ii. Water pollution: Introduction, classification of water pollutants, methods used in waste water treatment.
- iii. Soil pollution : Introduction, causes of soil pollution, control of soil pollution.

#### Recommended Books :-

1. Engineering Chemistry	-	P.C. Jain
2. Engineering Chemistry	-	S.S. Dara
3. Engineering Chemistry	-	Agrawal
4. Polymer Chemistry	-	Gowarikar.

#### INDCH-103 CHEMICAL PROCESS TECHNOLOGY-I/BASIC PRINCIPLES OF CHEMICAL PROCESSES

Importance of Chemical Industry, its Development and Growth.

Importance of the chemical industry, New Developments in Chemical Technology, The Quality and production cost of Chemical processes.

#### Basic Principles of Chemical Technology

Chemical Technological process, Classification of Chemical Technological process, Chemical Equilibrium, Rates of Chemical and processes, method of increasing the process rates, Technological Schemes.

#### Reactors types

Homogeneous processes, Heterogeneous processes in Gas-liquid, Liquid-solid & Gas Solid.

Introduction to unit processes and unit operations

#### Industrial Processes

Sulphur Industries - Production of Sulphuric acid

Nitrogen Industries - Production of Nitric acid, Ammonia, Urea, Ammonium Nitrate.

Phosphorus Industries - Production of Calcium phosphates

Cement and lime Industries

Starch and sugar industries

Inorganic pigments - White, blue & yellow

Chlor - Alkali Industries - Soda ash Bicarbonates, alkalies, Chlorine, Caustic soda.

#### Recommended Books

1. C.E. Bryden, Outline of Chemical Technology- Ed. by M. Gopal Rao & Marshall Sittig Affiliated East-West Press.
2. W.N. Shreve & C.A. Brink, Chemical Process Industries. McGraw Hill, 3rd Ed.

# INDCH-104 ANALYTICAL METHODS & USE OF COMPUTERS IN CHEMISTRY

## Section - I

1. Chromatography : Principles and classification of various techniques.
2. Study of following chromatographic techniques: Column chromatography, paper chromatography, electrophoresis, ion exchange chromatography, exclusion chromatography, thin layer chromatography. Introduction to G.L.C. and H.P.L.C.
3. Flame photometry : Introduction, principle, instrumentation, applications, Interferences. factors affecting the intensity of emitted radiation.
4. Nephelometry and turbidimetry : Introduction, turbidimetry and colorimetry, nephelometry and fluorimetry, choice between nephelometry and turbidimetry theory, instrumentation and application.
5. pH metry : Definition, determination, hydrogen electrode, quinhydrone electrode glass electrode, instrumentation pH titration.
6. Polarography and related techniques A brief account of polarography, introduction, apparatus used for amperometric titrations, techniques and types of amperometric titration titrations with two indicator electrodes, advantages and disadvantages of amperometric titrations, applications, cyclic voltammetry, chronopotentiometry.

## Book Recommended

1. Basic concepts in Analytical Chemistry - S.M. Khopkar, Wiley Eastern.
2. Instrumental Methods of Analysis - by H.H. Willard, L.L. Merritt, J.A. Dean 5th Ed.
3. Instrumental Methods of chemical Analysis - by G. Chatwal, J. Anand, Himalaya Publishing house.

## Section - II

1. Introduction  
Introduction to computers  
History and development of computers  
Generations of computers

### Computers hardware

CPU and other peripheral devices  
Input/Output devices  
Memory bits and bytes

### Computer software

Programming languages  
Machine language, assembly languages and higher level languages.

### 3. Disc Operating Systems

MS-DOS  
Fundamentals  
RAM and ROM

### 4. Flow Charting

introduction  
Use of flow charts  
Symbols used to draw flow-charts  
Examples

### 4. Basic

introduction to BASIC  
Constants, variables, strings, operators & expressions  
Use of parenthesis

Statements : REM, LET, PRINT, INPUT, STOP, END, READ-DATA  
GOTO, IF-THEN, IF-THEN-ELSE, FOR-NEXT

Library functions - SIN, COS, TAN, LOG

Writing a Basic program:

Simple Programs (at least 10)

1. Conversion of Centigrade to Fahrenheit
2. Estimation of Phenol/Aniline
3. Estimation of Amide
4. Estimation of Nitro groups
5. To find the no. of COOH groups in a compound
  - i. Titration method
  - ii. Silver salt method
6. Saponification value
7. Iodine value
8. Ore analysis
9. Conductometry
10. Potentiometry
  - i. Refractometry
  - ii. Allometry
11. Victor Meyer's method
12. Conversion factors for different units
13. Kinetics
  - i. 1st order
  - ii. 2nd order

5. General information about the packages
- Wordstar
    - Writing a letter
  - dBASE
    - Sorting records in a file on different heads
  - LOUTS
    - Spreadsheet
    - Use in chemistry
    - Printing of graph
- Other scientific application packages

#### Book Recommended

1. BASIC Programming for chemists  
F.C.Kara, T.L.Jsenhour & C.L.Wilkins  
J.Wiley, 1987
2. Computer Applications in chemistry:  
K.Ebert, H. Ederer, T.L.Jsenhour:
3. Elements of Parallel Processing  
V. Rajaram, Prentice - Hall 1990.

#### INDCH-105 LABORATORY COURSE - I

##### List of Experiments for Ist Semester

##### PART A

1. Kinetics (Volumetric and colourimetry).
2. Saponification value.
3. Potentiometry
4. Determination of U.O.D.
5. ore analysis
6. iodine value
7. Complex preparation
8. Spectrophotometry

##### PART B

1. Conductometric titration of mixture of acids
2. Column chromatographic
3. Redox titrations.
4. Experiments on Potentiometry
5. Separation techniques
6. IR spectroscopy



PART C : LIST OF EXPERIMENTS FOR COMPUTER PROGRAMMING

Simple Programs (at least 10)

1. Conversion of Centigrade to Fahrenheit
2. Estimation of Phenol/Aniline
3. Estimation of Amide
4. Estimation of Nitro groups
5. To find the no. of - COOH groups in a compound
  - i. Titration method
  - ii. Silver salt method
6. Saponification value
7. Iodine values
8. Ore analysis
9. Conductometry
10. Potentiometry
11. Refractometry
12. pHmetry
13. Victor Meyer's method
14. Conversion factors for different units
15. Kinetics
  - i. 1st order
  - ii. 2nd order

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NOTE

STUDENTS ARE ADVISED TO COMPLETE AT LEAST 6 EXPERIMENTS FROM "PART A" AND 5 EXPERIMENTS FROM "PART B & C".

SEMESTER - II  
INDCH-201 CHEMICAL PROCESS CALCULATIONS

1. Dimensions and Units - Introduction, dimensions and system units, Fundamental quantities, derived quantities, conversions, recommendations for use of units

2. Basic Chemical Calculations - Introduction, mole, atomic and molecular weight, equivalent weight, solids, liquids, solutions, important physical properties of solutions, Gases

3. Material Balances Without Chemical Reactions - Introduction, process flowcharts, material balances, Graphical solution of problems, Recycling and bypassing operations  
Material balances of unsteady operations

4. Material Balances Involving Chemical Reactions - Introduction, Energy and thermochemistry, energy balances, heat capacity of gaseous mixtures, specific heat of liquid mixtures, latent heats, enthalpy change during phase transfer accompanied by sensible heat changes, equilibrium flash calculations of multicomponent system, enthalpy changes accompanying chemical reactions, absolute enthalpy, Adiabatic reactions, thermochemistry of mixing processes, dissolution of solids, liquid-liquid mixtures, gas liquid systems, heat of solution by partial molal quantities.

5. Stoichiometry and unit operations - Introduction, distillation, absorption and stripping, extraction and leaching, crystallization, psychrometry, Drying, Evaporation, Len conventional operations.

6. Combustion, Introduction, Fuels, Calorific Values of Fuels, Coal, Liquid Fuels. Air Requirement & Flue Gases Combustion calculation.

7. Stoichiometry & Industrial Problems Introduction.

8. Stoichiometry & Digital Computation-Introduction, Application / Justification Analog computation Vs Digital computation, Use of Programmable Calculators, Programming Languages, General Procedure.

Books Recommended

1. Stoichiometry- Bhatt B.T. & Vera Ed.2, TataMcGraw Hill
2. Basic principles and Calculations in Chemical Engineering - Himmelblau D.M., Ed.4, Prentice Hall
3. Chemical Engineering Calculations- Shukla S.D. & Pandey G.N. Lion Press, Kanpur

## INDCH-202: CHEMICAL ENGINEERING THERMODYNAMICS

Review of the first and second law of thermodynamics and other basic concepts, Carnot's cycle - engine and theorem, Otto engine, power engine, Rankine cycle, liquefaction of gases, Claude's process, Linde's process, Joule-Thompson effect, volumetric properties of pure fluids, heat effects and thermochemistry, thermodynamic properties of fluids, generalised correlations, property of homogeneous mixtures, partial molar properties, fugacity, fugacity coefficient, activity coefficients, phase equilibria, vapour-liquid equilibria, Gibbs - Helmholtz equation, chemical reaction equilibria, thermodynamics of heat processes, refrigeration.

### Books recommended :

1. Introduction to chemical reaction Thermodynamics  
Smith Van Ness, McGraw Hill.
2. Chemical Engineering Thermodynamics - G.N. Pandey,  
I.C. Chaudhari, Khanna Publishers, Delhi.
3. Chemical Thermodynamics - Reid, McGraw Hill.

## INDCH 203 ORGANIC REACTIONS AND SYNTHESIS

Aromaticity: Huckel's rule and concept of aromaticity; (n) annulenes and heteroannulenes; fullerenes (C<sub>60</sub>).

Stereochemistry and conformational analysis: Newer methods of asymmetric synthesis (including enzymatic and catalytic reactions), kinetic and diastereoselective synthesis, effects of conformation on reactivity in acyclic compounds and cyclohexane.

Characteristic Organic Name Reactions: Feavorskii reaction, Stock reaction, Wittig reaction, Michael addition, Mannich reaction, Sharpless asymmetric epoxidation, Ene reaction, Barton reaction, Hofmann-Löffler-Freytag reaction, Shapiro reaction, Bayer-Villiger oxidation, Birch reduction.

Mechanisms of Organic Reactions: Labelling and kinetic isotope effects, Hammett equation ( $\sigma$ - $\rho$ ) relationship, intramolecular carbonium ions, neighbouring group participation.

Pericyclic Reactions: selection rules and stereochemistry of Diels-Aldel reactions, cycloaddition and sigmatropic shift; Claisen, Huisgen, Cope and Cation rearrangements.

Heterocyclics, Synthesis and reactivity of furan, thiophene, pyrrole, pyridine, quinoline, isoquinoline and indole; Skraup synthesis, Fischer indole synthesis.

Reagent in Organic Synthesis. Use of following reaction in organic synthesis and functional group transformation. Complex metal hydrides. Gilman's reagent. lithium dimethylcuprate. lithium diisopropylamide. (LDA), dicyclohexylcarbodiimide, 1,3 dithiane (reactivity unpoising). trimethylsilyl iodide, tri-n-butyltin hydride, Woodward and Prevost hydroxylation. osmium tetroxide. DDQ. selenium oxide phase transfer catalysis. crown ethers and Merrifield resin. Peterson's synthesis. Wilkinson's catalyst: Baker yeast.

Chemistry of Natural Products: Familiarity with methods of structure elucidation and biosynthesis of alkaloids, terpenoids, steroids, carbohydrates and proteins. Components of proteins and nucleic acids.

#### Recommended Books

1. Organic Chemistry : Morrison & Boyd Allyn & Bacon Inc. Universal Book Stall.
2. Principle of Organic Synthesis - R.O.C. Norman, Chapman & Hall, London.
3. Some Modern Methods of Organic Synthesis - W. Carruthers Cambridge University Press.

#### INDCH-204 Instrumental Methods of Analysis :

1) Atomic absorption Spectroscopy : - Introduction, principle, differences between AAS and FES, advantages of AAS over FES, Advantages of AAS, Instrumentation, single and double beam AAS, detection limit and sensitivity, interferences, applications.

2) IR Spectroscopy - Molecular vibrations, Factor influencing vibrational frequencies, instrumentation, IR sources, optical system, detectors process analysis, sampling techniques, interpretation of spectra : - Quantitative analysis, ATR & MIR reflectance, FTIR spectroscopy.

3) UV & Visible spectroscopy - Theory of electronic spectroscopy, instrumentation & sampling applications, visual spectroscopy, visual colorimetry, Photometric filter photometry, spectrophotometry, simultaneous spectrophotometry, differential spectrophotometry, photometric titrations.

4) NMR Spectroscopy - Proton NMR spectroscopy, The NMR phenomenon, theory . Chemical shifts and its measurement, factors influencing chemical shifts, sample handling & instrumentation, solvent used in NMR, spin spin coupling, spin spin splitting, bond multiplicity, applications, derivative curves of values,

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Hyperfine splitting. Introduction to C

### Recommended Books

- 1) Basic concepts in Analytical Chemistry - S.M.Khopkar, Wiley Eastern.
- 2) Application of Absorption Spectroscopy of Organic Compounds - John R. Snyder, Prentice Hall of India
- 3) Physical Biochemistry - Fricfeldor
- 4) Organic Spectroscopy - William Kemp
- 5) Analytical Biochemistry - D. Holme & H. Peck
- 6) Instrumental Methods of Chemical Analysis - Willard, Merit. Dean
- 7) Instrumental Methods of Analysis - Chatwal & Anand

### INDCH-205 Laboratory-II

1. Intrinsic measurement and relationship of viscosity with molecular weight of polymers.
2. End group analysis
3. Viscosity measurement by Brookfield viscometer.
4. Flash point measurement by Pensky Marken's apparatus
5. Flash point measurement by Abel's apparatus
6. Synthesis of PE/UE/EE polymers
7. Synthesis of polyethylene terephthalate
8. Determination of B.O.D.
9. Measurement of relative surface tension of solvents.
10. Synthesis of glyptal resin.
11. Estimation of monomer concentration.
12. Determination of degree of swelling of a polymer.
13. Kinetics of condensation polymerization.
14. Reactivity ratios determination.
15. I.R. spectroscopy
16. N.M.R. spectroscopy
17. Emulsion polymerisation of styrene
18. Suspension polymerisation of styrene
19. Co polymerisation of styrene and MMA
20. Emulsion polymerisation of vinyl acetate
21. Synthesis of epoxy resin
22. Interfacial Polycondensation. (synthesis of Nylon 6.6.)

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