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# *SHIVAJI UNIVERSITY, KOLHAPUR*

Revised Syllabus of

## (S.E. Chemical Engineering Sem –III & IV)

To be introduced from the academic year 2014-15

(i.e. from June 2014 ) Onwards

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

**Shivaji University, Kolhapur**

Syllabus Structure of Second Year Chemical Engineering Course

**Scheme of Teaching and Examination**

**SEMESTER – III**

| Sr. No. | Name of the Subject | Teaching Scheme(Hrs) | | | | Examination Scheme (Marks) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | Total | Theory | TW | Pract /Oral | Total |
| 1 | **Engg. Maths-III **** | 3 | 1 | -- | 4 | 100 | 25 | -- | 125 |
| 2 | **Chemistry-I** | 4 | -- | 2 | 6 | 100 | 50 | 50 | 200 |
| 3 | **SOM & MOC** | 3 | -- | 2 | 5 | 100 | 25 | -- | 125 |
| 4 | **Fluid Mechanics** | 3 | 1 | 2 | 6 | 100 | 25 | 25 | 150 |
| 5 | **Mechanical Operations** | 4 | -- | 2 | 6 | 100 | 25 | 25 | 150 |
| 6 | **Computer Practice-I** | 1 | -- | 2 | 3 | -- | 50 | -- | 50 |
| | **Total** | **18** | **2** | **10** | **30** | **500** | **200** | **100** | **800** |

** Engineering mathematics – III

**SEMESTER – IV**

| Sr. No. | Name of the Subject | Teaching Scheme(Hrs) | | | | Examination Scheme (Marks) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | Total | Theory | TW | Pract /Oral | Total |
| 1 | **Engg. Maths-IV** | 3 | -- | -- | 3 | 100 | -- | -- | 100 |
| 2 | **Chemistry-II** | 4 | -- | 2 | 6 | 100 | 50 | 50 | 200 |
| 3 | **Process Calculations** | 4 | 1 | -- | 5 | 100 | 25 | -- | 125 |
| 4 | **Heat Transfer** | 3 | 1 | 2 | 6 | 100 | 25 | 25 | 150 |
| 5 | **Chemical Engg. Thermodynamics-I** | 3 | -- | -- | 3 | 100 | 25 | -- | 125 |
| 6 | **Computer Practice-II** | 1 | -- | 2 | 3 | -- | 50 | -- | 50 |
| 7 | **Fluid Machinery** | 2 | -- | 2 | 4 | -- | 25 | 25 | 50 |
| | **Total** | **20** | **02** | **8** | **30** | **500** | **200** | **100** | **800** |

**SECOND YEAR CHEMCIAL ENGINEERING**
**SEMESTER – III**

# 1. ENGINEERING MATHEMATICS – III

Teaching Scheme
Lectures: 3 hours/week
Tutorial: 1 hour/week

Examination Scheme
Theory: 100 marks
Term work: 25 marks

**Objective**

1) To reach mathematical methodologies and models.
2) To develop mathematical skills and enhance logical thinking power of students.
3) To provide students with skills in integral calculus, differtial equation and numerical techniques which would enable them to devise engineering solution for given situation may encounter in their profession
4) To produce graduates with mathematical knowledge, computational skills and the ability to deploy these skills effectively in the solution of problems, principally in the area of engineering.

**SECTION -1**

**Unit 1 Linear Differential Equations: (6L)**
**1.1** Linear Differential Equations with constant coefficients Defination, Complementary function and Particular integral (without method of Parameters).
**1.2**Homogenous linear differential equations.

**Unit 2 Application to Linear differential equations (7L)**
2.1 System of simultaneous Linear differential with constant coefficients.
2.2 Chemical reactions and solutions (mixture problems).
2.3 Conduction of heat.

**Unit 3 Numerical Analysis (7L)**
3.1 Approximation and round of errors, significant digits
3.2 Truncation errors and Taylor's series
3.3 Determination of roots of polynomials and transcendental equations by
- 3.3.1 Bisection method
- 3.3.2 Newton Raphson method
- 3.3.3 Secant method

**SECTION-II**

**Unit 4 Laplace Transform:** (6L)
4.1 Defination, Transforms of elementary functions
4.2 Properties of Laplace transform
4.3 Transform of derivatives and integral

**Unit 5 Inverse Laplace Transform: (7L)**
5.1 Inverse Laplace Transforms formulae.
5.2 Inverse Laplace Transforms.
5.3 Solution of Linear differential equation with constants coefficients by Laplace Transforms method.

**Unit 6 Curve fitting: (7L)**
6.1 Lines of regression of bivariate data
6.2 Fitting of curves by method of least-squares
- 6.2.1 Fitting of the straight line
- 6.2.2 Fitting of parabola
- 6.2.3 Fitting of exponential curve

**General Instructions:**
1. For the term work of 25 marks, batch wise tutorials are to be conducted. The number of Students per batch should be as per university pattern for practical batches.
2. Minimum number of assignments should be 8 covering all topics.

**Nature of Question paper:**
1. There will be two sections carrying 50 marks each.
2. There will be four questions in each section and three questions should be attempted from each section

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**Reference Books**:
1. A text book of Applied Mathematics: Vol. I, II and III by J. N. Wartikar & P. N. Wartikar, Vidyarthi Griha Prakashan, Pune.
2. Higher Engineering Mathematics by Dr. B. S. Grewal.
3. Advanced Engineering Mathematics by Erwin Kreyszig.
4. Advanced Engineering Mathematics by H.K.Das(S.Chand Publication)
5. Advanced Engineering Mathematics by Merle C.Potter (OXFORD University Press)
6. Numerical Methods by Saumyn Gupa, Rajesh Srivastava(OXFORD University Press)
7. Higher Engineering Mathematics by B.V.Ramana (Tata McGraw Hill Education)

# CHEMISTRY –I

Teaching Scheme
Lectures: 4 hours / week
Theory:100 marks

Examination Scheme
Practical: 2 hrs/week
Term Work: 50 Marks
Practical / Oral: 50 Marks

**Objective**

1) To impart the basic concepts of physical chemistry
2) To give the basic knowledge of chemical reaction engineering, and mass transpers.
3) To study the different analytical chemistry.
4) To study the concepts of organic chemistry.
5) To develop awareness of industrially importance of organic reactions
6) To understand mechanism of organic reactions.

## Section –I (Physical Chemistry)

**Unit 1 – a) Chemical kinetics ( 6 Lectures )**
Introduction, Order and Molecularity of reaction, Rate of reaction, Rate constant,
**First order reactions:** Definition, Examples, Derivation and Characteristics of first order reaction, Numericals.
**Second order reaction:** Definition, Examples, Derivation with equal concentration and Characteristics of second order reaction, Numericals, Zero order reaction.
**Pseudo unimolecular reactions:** Determination of energy of activation using Arrhenius equation and numericals. Methods to determine order of reaction

**b) Phase Rule & Distribution Law ( 7 Lectures)**
**Phase Rule :**Introduction, Gibbs Phase Rule equation and explanation of terms involved in the equation. Phase diagram, One component systems: Water and Sulphur system
**Distribution Law:** Introduction, Nernst distribution law, Solubility and distribution law, Explanation & limitations of distribution law, Henry's law, Numericals.

**Unit 2 - Photochemistry (6 Lectures)**
Introduction, Difference between thermal and photochemical processes,
**Laws of photochemistry:** Grothus-Draper law & Stark - Einstein law,
**Quantum yield:** Reasons for high and low quantum yield, Numerical Problems on it. Jablonski diagram,
**Fluorescence and Phosphoresce**, Difference between fluorescence and hosphoresce.

**Unit 3 - Volumetric Analysis ( 7 Lectures)**
Introduction,Anaytical chemistry, Qualitative and Quantitative analysis, Volumetric analysis ,Theory of volumetric analysis, Terms involved in titration Types of volumetric analysis and it,s importance, Primary and Secondary standard substances, Strength of solutions( Normality, Molarity, Molality,Formality,%,Mole fraction) Numericals based on calculation of strength of solution,

## SECTION – II (Organic Chemistry)

**Unit 4 - Organic Reactions & Reactive Intermediates: ( 7 Lectures)**
**Types of Organic Reaction:** Addition, substitution, Elimination, Rearrangement and polymerization
**Reactive Intermediates:** Carbocation, Carbanion, Carbon Free Radicals and Carbenes – their formation, structure & stability. Reactions involving formation of reaction intermediates like
**Carbocation :** Friedal Craft's reactions.
**Carbanion :** Aldol condensation reaction.
**Free radical :** Free radical polymerization of ethylene to polyethylene.
**Carbenes :** Reimer-Tiemann Reaction

**Unit 5 - Chemistry of Dyes (7 Lectures)**
Introduction, Qualities of good dye, Witt's Theory i.e. chromosphere- auxochrome theory, Colour and chemical constitution, Classification of dyes based upon structure & methods of application, Diazotization and coupling for azo dyes, Synthesis and applications of dyes like methyl orange ,Malachite green and Alizarin.

**Unit 6 – a) Chemistry of Surfactants (6 Lectures)**
Introduction of surfactants,
**Soaps:** Types of Soaps, Structure of Soap molecule, Cleansing action of soaps, Saponification and saponification value, Manufacture of soap by Modern process,
**Detergents:** Types, Properties and applications, Cleansing action of detergents, Comparison of Soaps and detergents.

**b) Unit processes in organic synthesis (6 Lectures)**
Introduction, Types of Reagents, Types of unit processes and general mechanism with suitable example of Nitration, Oxidation and Reduction,

## PRACTICALS (Minimum 10 Experiments should performed)

**A) Chemical Kinetics: (Any THREE)**
1) Determination of reaction rate constant of catalyzed hydrolysis of methyl acetate in 0.5N HCl
2) Determination of reaction rate constant of catalyzed hydrolysis of methyl acetate in 0.5N $H_2SO_4$
3) Determination of reaction rate constant of reaction between K2S2O8 & KI (Unequal conc.)
4) Determination of reaction rate constant of reaction between $KBrO_3$ & KI (Equal conc.)
5) Study of decomposition of hydrogen peroxide ($KMnO_4$ method)

**B) Organic Spotting:** (**Minimum FIVE** compounds with one must **liquid**)
Identification of organic compounds

| Compounds | Examples |
|---|---|
| **6) Acidic** (Any one) | Benzoic Acid, Salicylic acid, Oxalic acid, Acetic acid |
| **7) Phenolic** (Any one) | α-Naphthol, β-Naphthol, Phenol |

**8) Basic** (Any one) o/m/p-nitroaniline, Aniline

**9,10) Neutral** (Any two) Ethanol, Acetone, Acetamide, Benzamide, Acetanilide, Glucose. Naphthalene

**C) Preparations & Purification of some simple organic compounds (Any ONE)**

12) Preparation of benzene azo-β-naphthol dyestuff

13) Preparation of Soap

Note: Purification can be done by Sublimation, Filtration, Crystallization, Simple Distillation, Steam Distillation, TLC etc.

**D) Organic Estimations: (Any ONE)**

14) Determination of saponification value of the given oil sample

15) Estimation of Glucose in Glucon-D

16) Estimation of Acetone

**Reference Books for Physical chemistry:**

1. Physical chemistry -- Puri & Sharma (Shobanlal Nagin Chand - 2005)
2. Essentials of Physical chemistry -- Bhal & Tuli (S. Chand & Co. - 2005)
3. Principles of Physical chemistry--Prutton & Maron (oxford & IBH Publishing Co. Pvt. Ltd 1972)
4. Text book of physical chemistry - Gladstone (Macmillan India Ltd. - 1995)
5.Inorganic Chemistry - A. I. Vogel

**Reference Books for Organic Chemistry:**

1. Organic chemistry – Volume I& II- Finar & Finar (English language book society-1989)
2. Organic chemistry -- Fieser & Fieser
3. Organic chemistry -- Bhal & Bhal(S. Chand -2000)
4. Organic chemistry -- P.L. Soni (S. Chand -1994)
5. Organic reactions and mechanism – Pitter Sykes (Orient Longman-1986)

**Reference Books for Practicals**

1. Practical organic chemistry -- A. I. Vogel (CBS-1987)
2. Laboratory experiments for General, Organicand biochemistry 4th Edition, Bettelheim & Lanesberg
3. Experiments in applied chemistry –Sunita Rattan (S. K. Kataria & Sons- 2002)
4. Vogel's Textbook of Quantitative chemical analysis, 5th edition,

# 3. STRENGTH OF MATERIALS AND MATERIALS OF CONSTRUCTION

Teaching Scheme
Lectures: 3 hours / week

Examination Scheme
Practical : 2 hrs/week
Term Work:
Internal: 25 Marks

**Section –I**
**Strength of materials**
**Objective**

Students are expected to learn stress-strain relationship, concept of simple stresses, working stresses, elastic constant. The analysis of two dimensional stress system. They are expected to understand design of shafts, thin cylinders and thick cylinders. Also calculations of bending stresses are to be understood.

**Unit 1 -** Introduction to strength of materials: Equilibrium of rigid beam under general force system, concept of stress, simple stresses and strain, ultimate and working stress, Properties of materials, elastic constant relation between elastic constants, compound bars, temperature stresses. (6L)

**Unit 2 -** Analysis of two-dimensional stress system: Principal stresses, Mohr's circle of Stress.

Torsion of shafts: Torsion equation, strength and stiffness of solid and hollow circular shafts. Transmission of power. (7L)

**Unit 3 -** Thin cylindrical and Spherical shells: Subjected to fluid pressure wire wound cylinders.

Thick Cylinder: Lamis theory, Design of thick cylindrical shell, Thick Spherical Shells.

Direct and bending stresses: Introduction, Direct and eccentric loading, limits of eccentricity, core of section, wind pressure. (7L)

**Section – II**
**Materials of construction**
**Objective**

The students completing this course are expected to understand the materials of construction in chemical engineering. Also they will understand basic properties and mechanical properties of materials. They will recognize and understand the selection of right material of construction. They will also come to know that how the material failure takes place. The factors responsible for failure of materials i.e. either mechanical breakdown or corrosion. They will recognize materials standard and specifications. They are expected to understand economics in material selection. They will come to know that different types of materials available.

**Unit 4 -** Introduction, Introduction to Mechanical properties of materials (4L)
**Unit 5 -** Selection of right material, Materials Failure (4L)

**Unit 6-** Materials standards and specifications, Economics in material selection.
Materials available:
a) Ferrous metals, alloys and fabrication characteristics
b) Non-ferrous metals, alloys and fabrication characteristics
c) In organic Nonmetallic Glass & Glass steel, Porcelain and stoneware, Cement and concrete, Soil, Asbestos & rock wool.
d) Organic Non-metallic: Thermoplastics, Thermo-setting plastics, Rubber & Elastomers, Asphalt, Carbon and Graphite, wood.
e) Coatings, Lining/ cladding
f) High & Low temperature materials
g) Comparison of various materials
Corrosion: a) Types of corrosion - Galvanic corrosion, Crevice corrosion, Erosion corrosion, Stress corrosion.
b) Corrosion Prevention- Material selection, Coatings, Economics. (12L)

**Term Work:**
1. Tension test on mild steel.
2. Compression test on mild steel and timber
3. Hardness test – brinell and Rockwells
4. Torsion test
5. Impact test charpy and izod.
6. Shear test-double shear

STRENGTH OF MATERIALS

**References :**

1. Punmia B.C. 'Strength of Materials and Mechanics of Structure'-Vol.I- Standard Publications, Delhi.
2. C. Patel, T.D. Bhagia, 'Strength of Materials ' Vol. I, C. Jamnadas & Co. Mumbai
3. Ramamruthm, 'Strength of Materials' , - Dharapatray & Sons, Delhi , 1998.
4. Sarkar B.K. 'Strength of Materials', -- Allied Publishers, New Delhi , 2001.
5. William Nash, 'Strength of Materials', IVth Ed. McGraw Hill Publication.

MATERIALS OF CONSTRUCTION

**Reference:**

1. Bhattacharya B.C., 'Selection of materials and fabrication for Chemical Process Equipment, Chemical Engg.' , Educational Development Centre , IIT Madras
2. Coulson & Richardson 'Chemical Engineering', Volume VI, Pergamen Press .
3. Robert N. Perry & Don Gress , 'Perry's Chemical Engineers Handbook', VIth ed. McGraw Hills International Ed. Newyork 1984.
4. D. Venkateswarlu & other, Chemtech -I, 'First volume of manual of Chemical Technology', Chemical Engg. Educational Development Centre, IIT Madras.
5. Corrosion Engineering IIndedition Mars G.Fontana.

## 4. FLUID MECHANICS

Lectures: 3 hrs
Tutorial: 1 hour/week

Theory: 100 marks
Practical: 2 hrs / batch / week
External- 25 marks
Internal- 25 marks

### Objective

The students completing this course are expected to understand the importance and the role of fluid mechanics & fluid moving machinery in the field of chemical Engg. They will be able to understand the how the momentum balance can be made by considering the nature of the fluid, as it applies to the internal & external fluid flow systems. They are able to understand the behavior of fluids & their basic equations such as Bernoulli's Equation without friction & with friction and also flow of compressible fluids. They are also expected to understand the transportation, metering of fluids, flow past immersed bodies, Ergun's equation, and concept of fluidization and agitation of fluids.

### Section -I

**Unit 1 -** Unit systems: Physical quantities, S.I., CGS, FPS engg. units, Conversion of Units, Units and Equations, dimensional analysis, Application of dimensional analysis, Problems.

Fluid statics and its applications : Nature of fluids, Hydrostatic equilibrium, Barometric equation, Hydrostatic equilibrium in centrifugal field, Manometers, Example, U tube, Inclined tube manometers. (6L)

**Unit 2 -** Fluid flow phenomena : Behaviour of flowing fluid, Types of flow, Newtonian and non-Newtonian Fluids, viscosity and momentum flux, viscosities of gases and liquids, Turbulence, Reynolds experiment, Eddy viscosity, Flow in boundary layers, Laminar and Turbulent flow in Boundary layers, Boundary layer formation in straight tubes, Boundary layer separation and wake formation

Basic equations of fluids flow : Mass balance, mass velocity, momentum balance, Bernoulli's equation without and with friction, kinetic energy correction factor, correction for fluid friction, Pump bernoulli's equation , Eulers equation, Problems (7L)

**Unit 3 -** Flow of incompressible fluids in conduits and thin layers : Shear stress distribution in a cylindrical tube, relation between skin friction and wall shear, the friction factor. Relations between skin friction parameters. Laminar flow in pipes, Laminar flow of Newtonian fluids. Average velocity, kinetic energy correction factor (Derivation), Momentum correction factor (Derivation), Hagen-poiseuilie equation. Turbulent flow in pipes and closed channels. Velocity distribution for turbulent flow, universal velocity distribution equations for laminar sub layer and buffer layer, Relations between maximum and average velocities, Effect of roughness,The

friction factor chart ( Moody's diagram), friction factor in flow through channels of non-circular section, friction from changes in velocity or direction, Effect of fittings and valves, couette flow, Layer flow with free surfaces , Flow through annulas, Problems. (7L)

**Section – II**

**Unit 4 -** Flow of compressible fluids : Mach number, continuity equation,Total energy Balance, velocity of sound, ideal gas equations, the asterisk condition, stagnation temperature.

Metering of fluids: Measurement of flowing fluids. Venturimeter, orificemeter, Pitot tube, rotameter, target meters, vortex- shedding meters, turbinemeters, positive displacement meters, magnetic meters: ultrasonic meters. (6L)

**Unit 5 -** Flowpast immersed bodies : Drag coefficients of typical shapes, form drag and streamlining, Friction in flow through beds of solids, Erguns equation, Kozeny- Carman equation,Burke Plummer equation, Fluidization, Mechanism of fluidization, particulate andaggregative fluidization, minimum fluidization velocity, expansion of -fluidized beds, application of fluidization. (7L)

**Unit 6 -** Agitation of fluids: Agitation of liquids, Agitation equipment, flow patterns in agitatedvessels, circulation rates, Flow numbers, power consumption, power correlations, power correlations for specific impellers, effect of system geometry and calculations for power consumption. (7L)

**Term Work :**

1. Venturimeter
2. Orifice meter.
3. Reynold's experiment.
4. Bernoulli's experiment
5. Flow through helical coils
6. Flow through annular pipe
7.Flowthrough pipe & pipe fittings.
8.Flow through spiral coils
9.To study the properties of Newtonian and Non- Newtonian fluids.
10.Demonstration of –

a) Rotameter
b) Pitot tube

11. Flow through V-Notch and Open channel

**Text Book:**

1. Mc Cabe W.L. and Smith J.C. 'Unit operations of Chemical Engg.' VII ed. Mcgraw Hill Book Co., International ed. 1993

**References:**

1. Steeter U.L, 'Fluid Mechanics' V ed. Mc graw Hill Book Co., International Edn.1971.
2.Richardson J.E. and Coulson J.M. Chemical Engg. 3rd ed. Vol. 1 Pergamon Press1985.
3.Miohell B.I. Fluid and Particle Mechanics Pergamon Press 1970.
4 Gupta S.K., Momemtum Transfer Operations, Tata McGraw Hill, 1979.
5. Bansal R.K.' Texbook of Fluid mechanics and hydrolic machines', Firewall media, 2005.

# 5. Mechanical Operations

Lectures: 4 hrs
Practical: 2 hrs / batch / week

Theory: 100 marks
Practical:
External- 25 marks
Internal- 25 marks

**Objective**

Mechanical operations for chemical engineers deals with almost all mechanical operations such as particle size analysis, size reduction ,size separation by screening ,classification, jigging and dense medium separation,filtration,sedimentation,centrifugation,floatation,mixing and agitation ,gas-solid separations and handling and transport of solids this subjects intends to equip the students with concepts and principles as well as construction of the equipments used for handling mechanical operations in a chemical plant. This subject gives ides about principles of handling mixtures of solids, liquids and gases .It will help the student for understanding the principles of separation and purification technique of solid, liquid and gaseous mixture. Students will able to apply the knowledge of mechanical operations present in the chemical industry. Students will able to handle the equipments used to carry out the various mechanical operations carried out in chemical industry.

**Section I**

**Unit 1 - Properties and handling of particulate solids**

Particle characterization, Particle size measuring technologies, Particle size distribution, Mean particle size, Mixed particle sizes and shape. Properties of solid masses, Storage of solids (Bulk and Bin), Flow through Hoppers, Angle of repose and angle of friction, Introduction to conveying of solids. (9 L)

**Unit 2 - Size reductions**

Mechanism of size reduction, Energy for size reduction, Crushing laws, Methods of operating crushers, Classification of size reduction equipments, Types of crushing equipment, Factors affecting communiation, Heat control methods in size reduction.

Screening: Standard test screens, Standards of screen, Screen effectiveness, Comparison of ideal and actual screens, Industrial screening equipment. (12 L)

**Unit 3 - Mixing of solids and pastes**

The degree of mixing, Rate of mixing, Criteria for mixer effectiveness, Solid-liquid mixing, Mixing for paste and plastic masses, Solid-Solid mixing. (5 L)

## Section II

**Unit 4 - Filtration**

Classification of filtration, Types of filtration, Pressure drop through filter cake, Filter medium resistance, Sp.cake resistance, Washing of cake, Filter media and selection, Compressible filter cakes, Preliminary treatment of slurries before filtration, Filtration equipment, Filter selection, Filter press, Vacuum filters, Centrifugal filtration and Filtration calculations.

Sedimentation: Basic principles, Flocculation, Thickeners, Batch sedimentation test, Design procedure for gravity sedimentation tanks. (12L)

**Unit 5 - Gas Cleaning**

Introduction, Gas cleaning equipment, Gravity separators, Centrifugal separators, Momentum separators, Electrostatic precipitators, Liquid washing, Odour removal, Fabric filters, Impingement method and Miscellaneous methods, Agglomeration and Coal essence. (8 L)

**Unit 6 - Benefaction Process in Chemical Engineering**

Froth flotation, Magnetic separators, Scrubbers, Jig classification, Heavy medium separation, Wilfiley table, Gravity settling tank. (6 L)

Practicals:

Any 10 Practicals should be conducted.

1. Sieve Analysis
2. Screen Effectiveness
3. Jaw Crusher
4. Pulverizer
5. Ball mill
6. Sedimentation(Batch)
7. Beaker Decantation
8. Filter Press
9. Leaf Filter
10. Cyclone Separator
11. Air Elutration
12. Rotary Drum Filter

Demonstration of following equipment and include in journal

1. Riffled Table
2. Mineral Jig
3. Froth Flotation

Industrial Visit:

Industrial visit to Sugar industry, Distillery industry or any other chemical industry.
Visit report should be submitted inclusive of following topics conveying, screening, filtration, cyclone separator, crusher etc.

Text Book

1. Mccabe W.L. & Smith J.C. and Peter Harriott, Unit Operations of Chemical Engg. 5th ed. Mcgraw Hill International.

2. C.M.Narayanan, B.C.Bhattacharyya, Mechanical Operations for Chemical Engineers, Computer Aided Analysis, Khanna Publishers.
3. J.F.Richardson & J.H.Harker with J.R.Backhurst, coulson & Richardson's, Chemical Engineering, vol 2,1st ed., Pergamon Press.

References:

1. Foust A.G. et.a- Principles of Unit Operations, 3nd ed. John, Wiley & Sons, New York 1979.
2. G.C.Sekhar, unit Operations in Chemical Engineering, Pearson education (Singarore) Pte. Ltd.

# 6. COMPUTER PRACTICE - I

**Teaching Scheme** **Examination Scheme**
**Lectures : 1 hours / week** **Practical : 2 hrs/week**
**Term Work :**
**Internal : 50 Marks**

**Objective**

The students completing this course are expected to understand the importance and the role of computer programming in the field of chemical Engg. They will be able to develop the program based on the chemical Engineering application by using FORTRAN and C language. For example with the help of programming language, they will be able to design the heat exchanger, they can develop the program for vapour pressure, specific heat, flow through branching section, calculation of mole fraction, minimum number of stages, minimum Reflux Ratio & for the estimation of optimum diameter. They are also expected to develop the program for how the concentration will change with time

**Programming in "C"**

**Unit 1 -** Functions: Defining and accessing, passing, arguments (2L)

**Unit 2 -** Function prototype, recursion, Use of Library Functions (2L)

**Unit 3 -** Storage classes : Auto static, external register (3L)

**Unit 4 –** Structures (2L)

**Unit 5 –** Arrays (2L)

**Unit 6 -** File Handling in C. (2L)

**Term Work :**

1. To practice unix command
2. Making contact with Unix Login and Logout producer.
3. Practice commands like CAT, PG, PR, LE, CP, MV, RM, WC, CH, MODE, DIFF, GREP, SORT, TEXT.
4. To practice Novel network commands.
5. To practice FoxPro commands.
6. Database structure creation.
7. Use of editor and working with command window.
8. Quadratic equations
9. Small and Large numbers
10. Ascending and Descending order
11. Fibonacci numbers
12. Matrix addition , Substraction and multiplication.

**Text Books:**

1. Yashwant Kanitkar, Let us C, 4th Revised ed. BPB Publication, 1991.

2. E. Balagurusamy , Programming in ANSY C, 2nd ed. Mc-Graw Hills Publishing Co. 1989.
3. K.R. Venugopal and Sudeep R. Prasad , Programming with c, Mc-Graw Hills Publishing Co. 1997.

**References:**

1. Byron Gottfried , Programming with C , Mc-Graw Hills Publishing Co. 1998
2. Sumitabha Das, Unix Concepts and Applications, 2nd ed., Mc-Graw Hills Publishing Co 1998
3. Microsoft Ms-Dos Users Guide
4. Unix Users Guide manual
5. Novel Network Users Guide

## SEMESTER – IV

# 1. ENGINEERING MATHEMATICS – IV

Teaching Scheme
Lectures: 3 hours/week

Examination Scheme
Theory: 100 marks

**Objective**

1) To reach mathematical methodologies and models.
2) To develop mathematical skills and enhance logical thinking power of students.
3) To provide students with skills in integral calculus, differtial equation and numerical techniques which would enable them to devise engineering solution for given situation may encounter in their profession
4) To produce graduates with mathematical knowledge, computational skills and the ability to deploy these skills effectively in the solution of problems, principally in the area of engineering.

**SECTION -1**

**Unit 1: Vector Differential Calculus: (6L)**

1.1 Differentiation of vectors
1.2 Gradient of scalar point function and Directional derivative
1.3 Divergence of vector point function and solenoid vector field
1.4 Curl of a vector point function and Irrotational.

**Unit 2: Fourier Transforms (7L)**

2.1 Fourier Transforms.
2.2 Fourier sine and cosine transforms.
2.3 Inverse Fourier, Sine and Cosine transforms.
2.4 Complex form of Fourier integral.

**Unit 3: Numerical Differentiation (7L)**

3.1 Definition
3.2 Numerical differential by using
    3.2.1 Newton's forward difference interpolation formula
    3.2.2 Newton's backward difference interpolation formula
    3.2.3 Sterling's central difference interpolation formula
    3.2.4 Newton's divided difference formula

**SECTION-II**

**Unit 4 Probability Distribution: (6L)**

4.1 Random variable
4.2 Binomial Distribution
4.3 Poisson Distribution
4.4 Normal Distribution

**Unit 5 Fourier series**: (7L)
5.1 Definition, Euler's formulae, Dirchlet's Conditions
5.2 Functions having points of discontinuity
5.3 Change of interval
5.4 Expansions of odd and even periodic functions
5.5 Half range series.

**Unit 6: Application of partial differential equation (7L)**
6.1 Wave equation
    6.1.1 The method of separation of variables
    6.1.2 Fourier series solution of wave equation
6.2 One dimensional heat flow equation
    6.2.1 The method of separation of variables
    6.2.2 Fourier series solution of wave equation
6.3 The Laplace equation in two dimensional heat flow (Steady State)
    6.3.1 Solution of Laplace equations by Gauss-Siedel iterative method

**General Instructions:**
1. For the term work of 25 marks, batch wise tutorials are to be conducted. The number of students per batch should be as per university pattern for practical batches.
2. Minimum number of assignments should be 8 covering all topics.

**Nature of Question paper:**
1. There will be two sections carrying 50 marks each.
2. Each section should have three questions having internal option.

**Reference Books:**
1. A text book of Applied Mathematics: Vol. I, II and III by J. N. Wartikar & P. N. Wartikar, Vidyarthi Griha Prakashan, Pune.
2. Higher Engineering Mathematics by Dr. B. S. Grewal.
3. Advanced Engineering Mathematics by Erwin Kreyszig.
4. Advanced Engineering Mathematics by H. K. Das(S. Chand Publication)
5. Advanced Engineering Mathematics by Merle C. Potter (OXFORD University press)
6. Numerical Methods by Saumyen Gupa , Rajesh Srivastava(OXFORD University press)
7. Higher Engineering Mathematics by B.V.Ramana (Tata McGraw Hill Education)

# 2. CHEMISTRY –II

Teaching Scheme
Lectures: 4 hours / week
Theory:100marks

Examination Scheme
Practical: 2 hrs/week
Term Work: 50 Marks
Practical / Oral: 50 Marks

**Objective**

1) To study chelation and its advantages.
2) To study various aspects of fertilizers.
3) To become aware of industrially important reactions and preparation methods of important industrials chemicals.
4) To impart knowledge of heterocyclic chemistry.
5) To study chemistry of petrochemicals and polymers.
6) To study basic concepts and synthesis of pharamascuticals and agrochemicals.

**Section –I (Inorganic Chemistry)**

**Unit-1** **a) Inorganic Heavy Industries: (3 Lectures)**

Le Chatelier's principle, Manufacture of $H_2SO_4$ (contact process), $NH_3$ (Haber's process) w.r.t. reactions, Reactants, Catalyst and Physicochemical principles.

**b) Inorganic Chemicals used in Industry: (3 Lectures)**

Preparation, properties and uses of Ferrous Ammonium Sulphate(FAS), Ammonium Chloride, Sodium Hydroxide.

**c) Solvents (7 Lectures)**

Introduction, Importance of solvents in chemical reactions, Water as an universal solvents, Classification of solvents Characteristics, properties of solvents (M.P., B.P., Heat of fusion& vaporization, Dielectrical constant) study of few important non-aqueous solvents such as Liquid $NH_3$, Liquid HF and $CH_3COOH$ w.r.t. solvent characters and reactions**.**

**Unit-2** **Fertilizers (7 Lectures)**

Introduction, Classification of fertilizers, Needs and essential requirements of Fertilezers, Fertility and PH value of Soil mixed fertilizers ( NPK fertilizers ) , Complex fertilizers, Pollution caused by fertilizers, effect of fertilizers.

**Unit – 3** **Chelation ( 6 Lectures)**

Introduction w.r.t.chelating, chelation and metal chelate. Structural requirements of chelate formation. Difference between metal chelate and metal complex.
Classification of chelating agents ( with specific illustration of bidentate chelating agent ). Application of chelation w.r.t. EDTA and DMG.

**SECTION – II (Organic Chemistry)**

**Unit-4** **Chemistry of Heterocycles (8 Lectures)**

Introduction , Classification of Heterocycles,
**a) Five Membered Heterocycles :** Study of Pyrrole & Furan
Method of Synthesis: i) From Acetylene, ii) From succinamide/
Physical Properties
Chemical Properties:

i) Acidic & basic character, ii) Electrophilic Substitution Reactions
iii) Reduction, iv) Oxidation

**b) Six Membered Heterocycles :** Study of Pyridine

Method of Synthesis: i) From Acetylene & hydrogen cyanide, ii) From Piperidine
Physical Properties
Chemical Properties:
i) Basic character, ii) Electrophilic Substitution Reactions
iii) Reduction, iv) Nucleophilic Substitution Reactions
v) Oxidation

**c) Condensed Heterocycles :** Study of Quinoline

Method of Synthesis: Skraup's synthesis
Physical Properties
Chemical Properties:
i) Electrophilic Substitution Reactions, iii) Reduction,
ii) Nucleophilic Substitution Reactions, iv) Oxidation

**Unit-5 Polymers & Techniques (6Lectures)**

Polymers-definition, Compounding of Plastics, **Polymerization Techniques:** Bulk, Solution, Suspension and Emulsion, Preparation, Properties and Applications of Teflon, Polymethyl methacrylate (PMMA), Buna Rubber and Butyl Rubber**,**

**Unit-6 Chemistry of Petrochemicals (12Lectures)**

Introduction , Composition of Petroleum, Refining of crude oil, Cracking, Types of cracking, Octane number and Cetane number, Additives for improving antiknock properties, Chemistry of Major petrochemicals like Ethylene, Butadiene & Benzene.

**Biotechnology & Pharmaceuticals**

Introduction, Multidisciplinary nature of Biotechnology, Structure and composition of cell, molecules of life-Biomolecules – Carbohydrates, Proteins, Nucleic acids, Lipids, Enzymes. (Structure, function)

**Drugs:** Chemotherapy, Classification of drugs based on mode of action, Synthesis, properties and uses of Sulpha drugs (Sulphanilamide) and Analgesics (Paracetamol & Aspirin)

**PRACTICALS** (**Minimum 10** Experiments should performed)

**A) Inorganic**

**Quantitative Analysis: (Any 3)**

1) Determination of Percentage purity of FAS (Internal Indicator method)
2) Determination of Mg contents in Talcum powder
3) Estimation of Nitrogen from given given fertilizer sample.
4) Determination of Ca contents in pharmaceutical tablets, ores etc.
5) Determination of % purity of $H_2SO_4$, NaOH,$NH_3$.
6) Estimation of Acetic acid in given Vinegar sample

**B) Instrumental Analysis: (Any2)**

7) Estimation of Copper by colorimetric method

8) Estimation of Iron by colorimetric method
9) Estimation of Nickel by colorimetric method

**C) Organic Estimations: (Any 4)**

10) To determine the amount of vitamin C that is present in certain commercial food Products by the titration method.
11) Determination of amount of Aspirin in given Pharmaceutical Tablets
12) Determination of Nitrogen content in given ammonium fertilizer samples like ammonium chlorides, ammonium sulphates etc.
13) Estimation of Phenol
14) Estimation of Acetone
15) Estimation of Commercial Oxalic Acid
16) Estimation of Aniline

**D) Organic Preparations: (Any 1)**

17) Preparation of Aspirin from Salicylic acid
18) Preparation of Phthalic anhydride from Phthalic acid
19) Preparation of Benzoic acid from Benzamide

**Reference Books for Inorganic Chemistry:**

1)Selected Topics in Inorganic Chemistry by Wahid Malik, G.D.Tuli and R.D. Madan, S. Chand & compny, New Delhi,

2) Concise Inorganic Chemistry by J. D. Lee, ELBS

3) Basic Inorganic Chemistry by Cotton & Wilkinson, John Wiley & sons

**Reference Books for Organic Chemistry:**

1. Organic chemistry – Volume I& II- Finar & Finar (English language book society-1989)
2. Organic chemistry -- Fieser & Fieser
3. Organic chemistry -- Bhal & Bhal(S. Chand -2000)
4. Organic chemistry -- P.L. Soni (S. Chand -1994)
5. Organic reactions and mechanism – Pitter Sykes (Orient Longman-1986)

**Reference Books for Practicals**

1. Practical organic chemistry -- A. I. Vogel (CBS-1987)
2. Laboratory experiments for General, Organicand biochemistry 4th Edition, Bettelheim & Lanesberg
3. Experiments in applied chemistry –Sunita Rattan (S. K. Kataria & Sons- 2002)
4. Vogel's Textbook of Quantitative chemical analysis, 5th edition,

# 3. PROCESS CALCULATION

Lectures: 4 hrs per week
Tutorial: 1 hr per week

Examination:
Theory : 100 marks
Term Work : 25 marks

**Objective**

Students are to learn the fundamentals of basic chemical calculations. Students are introduced to the major type of calculations which needed to be performed in the design or analysis of chem. process. It provides a practice in carrying out these calculations by hand in each case to an appropriate degree of accuracy .It develops an understanding of the place of hand based calculations. It also provides a platform for using the physical and chemical properties and to estimate such data .The students are expected to carry out material and energy balance calculations for reactions and separation process. It also gives an idea to analyze the behavior of recycle process, performing material balances for various unit operations and unit process. It provides the opportunity to study the basic chemical calculations, gases systems, material balances, energy balances and combustion calculations.

**Unit 1 - Basic Chemical Calculations. (10 L)**

Units and Conversions, Pressure, Temperature, Density, Specific Gravity; Mole Concept, Equivalent Weight, Composition of solids, Liquids and Gases, Mass fraction, Mass percent, Mass Ratios, Mole fraction, Mole percent, Volume fraction and Volume percent, Normality, Molarity, Molality.

Gases Systems: Gaseous mixtures, Daltons law, Amagats law, Average molecular weight, Density of gaseous mixture, Estimation of vapour pressure.

**Unit 2 - Material Balances without Chemical Reaction. (9 L)**

Material balances; Guidelines for solving material balance problems; Material balance of important industrial operations (Distillation, Absorption and Striping, Extraction and Leaching, Evaporation, Dryer, Mixing, Crystallization etc.); Recycle and Bypass operations.

**Unit 3 - Material Balances with Chemical Reaction. (9 L)**

Definition of terms involved; Generalized approach for solving problems; Material balance problems involving chemical reaction; Recycle and purge calculations.

**Unit 4 - Energy Balance on Non Reactive Processes. (9 L)**

Elements of energy balance calculations; Change in pressure at constant temperature; Change in temperature; Phase change operations; Mixing and solutions.

**Unit 5 - Energy Balance on Reactive Processes. (8 L)**

Heat of reaction; Measurement and calculation of standard heat of reaction, Hess law; Heat of formation; Heat of combustion; Effect of temperature on heat of reaction; adiabatic reactions.

**Unit 6 - Fuels & Combustion. (7L)**

Calorific value of fuel, GCV & NCV of Fuel, Minimum air and Excess air requirement, Combustion calculations.

Reference Books:
1. Bhatt B.I. and Vora S.M. “Stoichiometry”, Fourth Edition, Tata McGraw-Hill Pub. Co. Ltd., 2004.
2. Himmelblau D.M., “Basic Principles and Calculations in Chemical Engineering”, Sixth Edition, Prentice-Hall of India Pvt. Ltd., 2004.
3. Felder R.M. and Rousseau R.W., “Elementary Principles of Chemical Processes”, Third Edition, John Wiley and Sons, Inc., 2000.
4. V. Venkataramani and N.Anantharaman., Process Calculations., 2003.
5. P.L.Ballaney, “Thermal Engineering”.

Note:-
Minimum 10 Tutorials should be conducted to solve unsolved problems.
Two Test of minimum 25 marks each should be conducted for term work.
Figure in bracket indicates lectures to be conducted.

# 4.HEAT TRANSFER

Teaching Scheme
Lectures : 3 hours / week
Tutorial : 1 hours / week
Practical: 2 hrs/week

Examination Scheme
Theory : 100 Marks
Term Work :
Internal : 25 Marks
External : 25 Marks

**Objective**

The students completing this course are expected to understand the nature and the role of the Heat transfer in the various operations of chemical Engg. They will be able to access the property data from the appropriate source which are useful for energy balance. They will recognize and understand the different modes of Heat transfer and restriction of the Energy laws. They will be able to understand the principles of Heat transfer in fluids, Heat transfer to fluids without phase change, and with phase change. They are expected to understand how the heat transfer takes place during Radiation & make the Enthalpy balance across the single effect evaporator & multiple effect evaporators. They will use this knowledge to simple design calculations of Heat Exchanger.

**Section – I**

**Unit 1 - Mechanism of heat flow:** Conduction, Convection, Radiation.
Heat transfer by conduction in solids: Fourier's law, steady state heat conduction through walls, single and multilayer. Heat flow through a cylinder, Sphere, unsteady state heat conduction, equation for one and three dimensional conduction, and introduction to semi-infinite solid and critical radius of lagging, Problems. (6L)

**Unit 2 - Principles of heat flow in fluids:** Typical heat exchange equipment, co-current and counter current flow. Energy balances, rate of heat transfer, overall and individual heat transfer coefficient. Calculation of overall heat transfer co-efficients from individual heat transfer coefficients, fouling factors. Transfer units in heat exchangers, Problems. (7L)

**Unit 3 - Heat transfer to fluids without phase change:** Regimes of heat transfer in fluids, thermal boundary layer, heat transfer by forced convection in laminar flow. Laminar flow heat transfer to flat plate, the Graetz and Peclet number. Average heat transfer coefficient in Laminar flow. Heat transfer by forced convection in turbulent flow, dimensional analysis method., effect of tube length, empirical equations, estimation of wall temperature, analogy equations. Heat transfer in transition region, heat transfer to liquid metals, heat transfer by forced convection outside tubes, natural convection, Problems. (7L)

## Section – II

**Unit 4 - Heat transfer to fluids with phase change :** Heat transfer from condensing Vapors dropwise and film wise condensation, coefficients for film type condensation, derivation and practical use of Nusselt equation, condensation of superheated vapors, effect of non-condensable gases, Problems. Heat transfer to boiling liquids : Types of boiling, boiling of saturated liquid maximum flux and critical temperature drop, minimum heat flux film boiling and subcooled boiling, Problems. (6L)

**Unit 5 - Heat exchange equipment**: Types of heat exchangers, single and multipass exchangers, correction of LMTD for cross flow. Simple design calculations of heat exchangers, introduction to compact heat exchanger i.e. plate type heat exchanger, different types of condensers and boilers, air cooled heat exchangers, introduction to heat transfer in agitated vessel, types, construction, definition of fin efficiency, problems.
Radiation heat transfer: Fundamentals of radiation, wavelength of radiation. emisivity.Laws of black body radiation, reflectivity, absorptivity of an opaque solids ,Kirchhoff's law,radiation between two surfaces. Calculation of radiation between black surfaces, combined heat transfer by conduction - convection and radiation, problems. (8L)

**Unit 6 - Evaporation:** Liquid characteristics, types of evaporators, single evaporator capacity, economy, boiling point elevation and Duhring's rule. Heat transfer co-efficients Enthalpy balance for single effect evaporator, multiple effect evaporators, types, methods of feeding, enthalpy balance of multiple effect evaporators, problems.
Introduction to heat transfer to packed and fluidized beds: General heat transfer characteristics, Calculation for Heat transfer co-efficient (6L)

**Term Work:**
1. Emissivity measurement apparatus.
2. Natural convection.
3. Forced convection.
4. Heat transfer through lagged pipe.
5. Thermal conductivity of metal rod.
6. Double pipe heat exchanger.
7. Packed bed heat exchanger.
8. Single and multiple effect evaporator.
9. Heat transfer through agitated vessel.
10. Shell and tube heat exchanger.
11. Fin tube heat exchanger.
12. Compact heat exchanger
13. Dropwise and filmwise condensation.
14. Critical heat flux.

Minimum 10 practicals are to be conducted.

**Text Books:**
1. McCabe W.L., Smith J.C. and Harriott P., “Unit Operations in Chemical Engineering” , 7th

edition McGraw Hill,2005.
2. Sukhatme S.P., “Heat Transfer”,5th edition.,University Press India Ltd.,1996.
References:
1. William H. Mcadams, “Heat transmission”, 3rd ed. McGraw Hill Series
2. Alan J. Chapman. “Heat Transfer”, 4th ed. Macmilan Publishing Company, New York
3. Frank Kreith & Mark S. Bohn. , “Principles of Heat Transfer”, 4th ed. Harper and Row Publishers, New York,
4. Coulson J.M. & Richardson J.F.,”Chemical Engineering” , 3rd ed. Vol.1
5. J.P. Holman. , “Heat Transfer” , 8th ed. Mc-Graw Hill Inc.1997.

## 5. CHEMICAL ENGINEERING THERMODYNAMICS-I

Teaching Scheme
Lectures : 3 hours / week

Examination Scheme
Theory : 100 Marks
Term Work :
Internal : 25 Marks

**Objective**

The students completing this course are expected to understand the nature and role of thermodynamics properties of matter, internal energy, enthalpy, entropy temperature pressure and specific volume. They will be able to access thermodynamics property data from appropriate sources. They are expected to understand temp-entropy or pressure-volume diagram as well as P-T diagrams. They will recognize and understand the different forms of energy and restrictions imposed by the first law of thermodynamics on conversion from one form to the other. They will understand implications of the second law of thermodynamics and limitations placed by the second law on the performance of thermodynamic system. They will be able to use isentropic process to represent the behavior of a system. They are expected to be able to quantify the behavior of power plants based on the Carnot cycle, Rankine cycle including the effect of enhancement such as superheat, reheat and regeneration. They are expected to quantify the performance of power generation based on the Otto cycle, Diesel cycle and Brayton cycle. They will be able to quantify the performance of refrigeneration & heat pump systems.

Section – I

**Unit 1 - Introduction:** Scope & limitations of thermodynamics, Dimensions and Units, Force Temperature , Pressure, Work energy and Heat, Problems. (4L)

**Unit 2 - First law of thermodynamics and other basic concepts**: Joules experiment, Internal energy, First law for non-flow process, Steady state flow processes, Equilibrium, The phase rule, Reversible and irreversible processes, Reversible chemical reaction, Enthalpy, Heat capacity, Constant volume and pressure process (8L)

**Unit 3 - Volumetric properties of pure fluids:** PVT behavior of pure substances, Virial equation of state, Ideal gas temperature, Universal gas constant, Two forms of virial equation, The ideal gas and equations for various processes, Problems, Application of the virial equation, Cubic equation of state. The vander wall equation of state (8L)

**Section – II**

**Unit 4 - Second law of thermodynamics**: Statements, Heat engine, Carnot theorem Ideal gas temperature scale, Carnot's equations,Thermodynamic temperature scale, concept of Entropy,

Entropy changes of an ideal gas,Significance of Entropy, Mathematical statement of second law entropy changes for open system,Third law of Thermodynamics, Problems. (6L)

**Unit 5 - Thermodynamic properties of fluids :** Property relations for homogeneous phases, Maxwell's relation, Enthalpy and Entropy as functions of temperature and pressure, Internal energy as functions of pressure, Ideal gas state, Alternate forms for liquids, Internal energy as function of T and V, Gibbs energy as generating function, Residual properties, Residual properties by equation of state, Application of thermodynamic equations to single phase systems, Two phase systems, Thermodynamic diagrams, P-H diagram, H-T diagram, T-S diagram, H-S diagram etc. (7L)

**Unit 6 - Conversion of heat into work by power cycles :** Steam power plant cycle, Internal combustion engines, Jet engines,Rocket engines.
Refrigeration and liquefaction : Carnot cycle, Air refregeration and vapor compression cycles, Choice of refrigerant. Absorption refrigeration, Heat pump, Liquefaction processes. (7L)

**Term Work**: Minimum five assignments covering all problems of the syllabus are to be Completed by the students.

**Text Book**:
1. J.M. Smith and H.C. Van Ness, "Introduction to Chemical Engg.", Thermodynamics 6th Edition,
International student edition, McGraw Hill publication.

**References**:
1. B.F. Dodge, "Chemical Engg. Thermodynamics", International student edition McGraw Hill Publication.
2. D.A. Hougen, K.M. Watson and R.A. Ragatz, "Chemical Process Principles", ( Vol. II ) 2nd Edn. Asia Publishing House.
3. K.V. Narayanan, "Chemical Engg. Thermodynamics", Prentice Hall India, New Delhi.

# 6. COMPUTER PRACTICES – II

Teaching Scheme
Lectures : 1 hours / week

Examination Scheme
Practical : 2 hrs/week
Term Work :
Internal : 50 Marks
External : Nil

**Objective**

The students completing this course are expected to understand the importance and the role of computer programming in the field of chemical Engg. They will be able to develop the program based on the chemical Engineering application by using FORTRAN and C language. For example with the help of programming language, they will be able to design the heat exchanger, they can develop the program for vapour pressure, specific heat, flow through branching section, calculation of mole fraction, minimum number of stages, minimum Reflux Ratio & for the estimation of optimum diameter. They are also expected to develop the program for how the concentration will change with time

**Programming in FORTRAN**

**Unit 1 - Programming and writing algorithms**: Introduction, Problem Analysis & Algorithm development, Algorithm, Flowcharting, Pseudo code, Flowchart and Pseudo code examples, Transformation of Pseudo code into a program, Program execution, program documentation (2L)

**Unit 2 - Introduction to FORTRAN :** Introduction, FORTRAN constants and variables, Type Declaration, Integer and real arithmatics, arith operation, the assignment Statement and arithmetic expressions and rules for it, FORTRAN statements Diftt statements in FORTRAN(3L)

**Unit 3 - Control structures :** Introduction, Selection decision or decision structure, GO TO statement, Repetition structure. (2L)

**Unit 4 - Files and I/P O/P** : Operations Introduction : Intro, Files, Programming processes, various statements ( e.g. OPEN, CLOSE, READ, WRITE ) Various formats, carriage control(2L)

**Unit 5 - Arrays** : Introduction, structure of Arrays, Array Declaration, one dimentional Array, Multi dimensional Arrays. (2L)

**Unit 6 - Subprograms** : Introduction, function of subprograms statement functions, subroutine sub programs, subprogram structure Diagrams, variable Array Dimension, Various statements ( e.g. Equivalence common, text., Int., Return, Save etc)Block Data Subprograms. (2L)

Term Work :
1. Matrix 6. Ascending sorting
2. Fibonacy numbers 7. Transpose of matrix
3. Quadratic equations 8. Addition of matrix
4. Small and large numbers 9. Reverse of given numbers

5. Descending sorting

Text Books:

1. P.S. Grover, “Programming and Computing with Fortran 77/90”, 2nd ed. Allied Publishers Ltd, 1996.
2. R.S. Salaria , “Programming in Microsoft Fortan 97”, 2nd ed., BPB Publications, 1994.
3. K.D. Sharma, “Programming in Fortran”, East-West Press Pvt. Ltd, 1976.
4. Seymour Lipschutz and Arthur poe, “Programming with Fortran”, Mc-Graw Hill, 1978.
5. V. Rajaraman, “Computer Programming in Fortran 90 and 95” , Prentice Hall of India, 1997.

# 7. FLUID MOVING MACHINERY.

Lecture: 2 hours/Weeks

Practicals: 2 hours/Weeks

Term work:
Internal: 25 Marks
External: 25 Marks

**Objective**

The students are able to understand the theory by performing practical to this course like pumps, fitting, flow measuring devices etc. The students completing this course are expected to understand the importance and the role of fluid motion in the field of chemical Engineering. They will be able to understand the basic principles of centrifugal pumps, compressors, reciprocating pumps and compressors/blowers and as well their applications in industries.

**Unit 1 -** Centrifugal pumps classification of pumps, classification of centrifugal pumps, theory of centrifugal pump, impellers, casings, volute pumps, volute pumps with vortex chamber, diffuser vanes (3L)

**Unit 2 -** Work done by centrifugal pumps, developed head of centrifugal pump, efficiency of centrifugal pump, minimum speed for functioning of centrifugal pump, multistage centrifugal pumps, pumps in series, pumps in parallel, specific speed of centrifugal pump, model testing suction lift, priming, binding, cavitation, effect of cavitation, NPSH, calculation of horse power requirement, operating characteristics, comparison, advantages and disadvantages, problems.(5L)

**Unit 3 -** Positive displacement pumps classification of positive displacement pumps, reciprocating pumps, volumetric efficiency, single acting, double acting, work done by reciprocating pumps, slip of reciprocating pump, variation in velocity and acceleration in suction and discharge line (5L)

**Unit 4 -** piston pumps, plunger pump, diaphragm pump, metering pump, rotary pump, rotary gear pump, rotary lobe pump, rotary vane pump, flexible vane pump, peristaltic pump, mono pump. (4L)

**Unit 5 -** Selection of pumps operating conditions, operating difficulties, comparison between various types of pumps, selection criterion in industries, maintenance of pumps. (3L)

**Unit 6 -** Fans, Blowers, and Compressors: Fans characteristics, operating pressure conditions, types of blowers, positive displacement blower, centrifugal blower, types of compressors, centrifugal compressor, reciprocating compressor, equations for blower and compressors adiabatic compression, isothermal compression, polytrophic compression, compressor efficiency, power equations, vacuum pumps, its working and principle, steam jet ejector, theory of compression, problems. (6L)

**Textbooks:**

1) Unit Operations of Chemical Engineering, Mc cabe Smith Harriott, McGraw Hill International Edition, Chemical Engineering Series.
2) Coulson & Richardson's Chemical Engineering, Volume VI, third edition, Chemical Engg. Design.

**Reference books**:

1) Fluid Mechanics by R. P. Vyas, Central Techno Publications, Nagpur.
2) Design for Chemical and Petrochemical Plants, Ernest E. Ludwig, Volume I & II, Gulf publishing Company.
3) Pumps : G.K.Sahu New age international publishers.

**Term Work :** Minimum five assignments covering all problems of the syllabus are to be Completed by the students.

**Practicals:**

1) Centrifugal pump test rig
2) Reciprocating test rig
3) Demonstration of fans and blowers
4) Study of centrifugal compressors
5) Study of gear pumps
6) Study of vacuum pumps
7) Study of peristaltic pumps