ENGINEERING MATHEMATICS – IV

Sub Code : 15MAT41	**IA Marks : 20**
Hrs/Week : 04	**Exam Hours : 03**
Total Hrs : 50	**Exam Marks : 80**

Credits: 04

[COMMON TO ALL BRANCHES]

PROCESS HEAT TRANSFER

Sub Code : 15CH42 **IA Marks : 20**
Hrs/Week : 04 **Exam Hours : 03**
Total Hrs : 50 **Exam Marks : 80**

Credits: 04

COURSE OBJECTIVES: The students will

1. Study various modes of Heat transfer and their fundamental relations.
2. Study conduction heat transfer and develop mathematical relations for various solid geometries.
3. Understand properties of insulation and critical thickness of insulation.
4. Understand different types of heat transfer coefficients and their estimations in various types of flows in different geometries.
5. Study the Boiling phenomenon and to generate pool boiling curve.
2. Understand the working of Heat exchangers and to learn design of double pipe, shell and tube heat exchangers and design of evaporators and conduct experiments and to submit the report.
3. Understand the phenomenon of radiation, radiation shields and estimation of emissivity.

Module 1	Content	Contact Hours	Blooms Taxonomy
INTRODUCTION: Various modes of heat transfer Viz. Conduction, Convection and Radiation. **CONDUCTION:**Fourier's law, Steady state unidirectional heat flow through single and multiphase layers slabs, cylinders and spheres for constant and variable thermal conductivity. **INSULATION:**Properties of insulation materials, Types of insulation, Critical and Optimum thickness.		**10Hrs**	**L-1, L-2, L-3**

Module 2	Content	Contact Hours	Blooms Taxonomy
EXTENDED SURFACES:Fins – Types of fins, Derivation of fin efficiency for longitudinal fins, Fin effectiveness, Elementary treatment of unsteady state heat conduction. **CONVECTION**:Individual and overall heat transfer coefficient, LMTD, LMTD correction factor, Dimensionless numbers, Dimensional analysis, Empirical correlation for forced and natural convection.		**10Hrs**	**L-1, L-2, L-3**

Module 3	Content	Contact Hours	Blooms Taxonomy
ANALOGY: Analogy between momentum and heat transfer- Reynolds, Colburn and Prandtl analogies. **HEAT TRANSFER WITH PHASE CHANGE:**Boiling phenomena, Nucleate and		**10Hrs**	**L-1, L-2, L-3**

Film boiling, Condensation - Film and Drop wise condensation, Nusselts equations. **HEAT TRANSFER EQUIPMENT**: Double pipe heat exchangers, Shell and tube heat exchangers – Types of shell and tube heat exchangers, Construction details, Condenser, types of condensers.		

Module 4	**Content**	**Contact Hours**	**Blooms Taxonomy**
DESIGN OF HEAT TRANSFER EQUIPMENT: Elementary design of double pipe heat exchanger, shell and tube heat exchangers and condensers. Numerical Problems.		**10Hrs**	**L-1, L-2, L-3**

Module 4	**Content**	**Contact Hours**	**Blooms Taxonomy**
EVAPORATORS: Types of evaporators, performance of tubular evaporator – Evaporator capacity, Evaporator economy, Multiple effect evaporator – Methods of feeding, effect of liquid head and boiling point elevation, Vapor recompression evaporation. **RADIATION:** Properties and definitions, Absorptivity, Reflectivity, Emissive power and intensity of radiation, Black body radiation, Gray body radiation, Stefen – Boltzmann law, Wein's displacement law, Kirchhoff's law, View factors, Radiation between surfaces, Radiation involving gases and vapors, Radiation shields.		**10Hrs**	**L-1, L-2, L-3,**

COURSE OUTCOMES: The students will be able to do the following

1. Write all fundamental heat transfer relations.
2. Derive equations for the calculation of heat flux and estimation of intermediate temperatures in multilayer systems.
3. Calculate critical thickness of insulation requires for different geometry of solids.
4. Write different dimensionless numbers and explain their significance.
5. Estimate LMTD and heat transfer coefficients for different types of flows.
6. Design Shell and tube and Double pipe heat exchanger, condensers and Evaporator.
7. Explain radiation in different type of solids and estimate emissivity.

Note: Use of steam tables permitted in examination and internal assessment test.

GRADUATE ATTRIBUTES:

- Problem analysis.
- Design/development of solutions.

QUESTION PAPER PATTERN:

- The question paper will have ten questions. Each full is for 16 marks. There will be two full questions (with a maximum of four sub questions) from each module. Each full question will

have sub questions covering all the topics under a module. The students will have to answer five full questions, selecting one full question from each module.

TEXT BOOKS:

1. Kern D.Q., **"Process Heat Transfer"**, McGraw Hill., New York, 1965
2. McCabe W.L., et.al., **"Unit Operations of Chemical Engineering"**, 5th edn., McGraw Hill, New York, 2000
3. Coulson J.M. and Richardson J.F., **"Unit Operations of Chemical Engineering"**, Vol-I, 5th edn., Chemical Engg, Perganon & ELBS, McGraw Hill, New York, 2000

REFERENCES:

1. Rao Y.V.C., "Heat Transfer", 1st edn., Universities Press (India) Ltd., New Delhi, 2001.
2. Dutta, Binay K., "Heat Transfer: Principles and Applications", PHI Learning. 2000.

CHEMICAL ENGINEERING THERMODYNAMICS

Sub Code : 15CH43 **IA Marks : 20**
Hrs/Week : 04 **Exam Hours: 03**
Total Hrs : 50 **Exam Marks: 80**

Credits: 04

COURSE OBJECTIVES: The students will

1. Learn fundamentals of thermodynamics such as types of properties, processes and laws of thermodynamics for flow and non flow process.
2. Understand the clear concepts on P-V-T behavior, Equations of state, thermodynamic diagrams and compressibility charts, entropy, irreversibility and problem solving skills.
3. Learn the thermodynamic properties of pure fluids, energy relations and fugacity concepts.
4. Study the estimation of partial molar properties, property changes of mixing, and ideal and non ideal solutions.
5. Learn the fundamentals of phase equilibrium, concept of chemical potential and generation and consistency check for VLE data.
6. Understand fundamentals of chemical reaction equilibrium to find feasibility and extent of conversion for the industrial reactions.

Module 1	**Content**	**Contact Hours**	**Blooms Taxonomy**
BASIC CONCEPTS: System, Surrounding and processes, Closed and Open systems, state and Properties, Intensive and Extensive Properties, State and Path functions, equilibrium state and Phase rule, Zeroth law of thermodynamics, Heat reservoir and Heat engines, Reversible and Irreversible processes. **FIRST LAW OF THERMODYNAMICS:** General statement of First law of thermodynamics, First law for cyclic process and non-flow processes, Heat capacity. **HEAT EFFECTS ACCOMPANYING CHEMICAL REACTIONS**: Standard heat of reaction, formation, combustion, Hess's law of constant heat summation, effect of temperature on standard heat of reaction.		**10Hrs**	**L-1, L-2.**
Module 2	**Content**	**Contact Hours**	**Blooms Taxonomy**
P-V-T BEHAVIOUR: P-V-T behavior of pure fluids, Equations of state and ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure, constant temperature, adiabatic and polytropic processes. Equation of state for real gases: Vander Waals equation, Redlich – Kwong equation, Peng – Robinson equation, Virial equation, Compressibility charts: Principles of corresponding states, generalized compressibility charts. **SECOND LAW OF THERMODYNAMICS:**General statements of the Second law, Concept of Entropy, the Carnot Principle, calculation of entropy changes, Clausius Inequality, Entropy and Irreversibility, Third law of Thermodynamics.		**10Hrs**	**L-1, L-2, L-3,**

Module 3	Content	Contact Hours	Blooms Taxonomy
THERMODYNAMIC PROPERTIES OF PURE FLUIDS: Reference Properties, Energy Properties, Derived Properties, Work function, Gibbs free energy, Relationships among thermodynamic properties, Exact differential equations, Fundamental property relations, Maxwell's equations, Clapeyron equations, Entropy heat capacity relations, Modified equations for U & H, Effect of temperature on U, H & S, Relationships between C_P& C_V, Gibbs-Helmholtz equation, Fugacity, Fugacity coefficient, Effect of temperature and pressure on Fugacity, Determination of Fugacity of pure gases, Fugacities of solids and liquids, Activity, Effect of temperature and pressure on activity, Thermodynamic diagrams		**10Hrs**	**L-1, L-2, L-3,**
Module 4	**Content**	**Contact Hours**	**Blooms Taxonomy**
PROPERTIES OF SOLUTIONS: Partial molar properties, Chemical potential, Fugacity in solutions, Henry's law and dilute solutions, activity in solutions, Activity coefficients, Gibbs – Duhem's equation, Property changes of mixing, excess properties.		**10Hrs**	**L-1, L-2, L-3,**
Module 5	**Content**	**Contact Hours**	**Blooms Taxonomy**
PHASE EQUILIBRIA:Criteria of phase Equilibria, Criterion of stability, Duhem's theorem, Vapor – Liquid Equilibria, VLE in ideal solutions, Non-Ideal solutions, VLE at low pressures, VLE at high pressures, consistency test for VLE data, Calculation of Activity coefficients using Gibbs – Duhem's equation. **CHEMICAL REACTION EQUILIBRIUM**: Reaction Stoichiometry, Criteria of chemical reaction equilibrium, Equilibrium constant and standard free energy change, Effect of temperature, Pressure on equilibrium constants and other factors affecting equilibrium conversion, Liquid phase reactions, heterogeneous reaction equilibrium, phase rule for reacting systems.		**10Hrs**	**L-1, L-2, L-3,**

COURSE OUTCOMES: The students are expected to do the following

1. Calculate the heat and work requirements for the given flow or non-flow processes.
2. Analyze and find properties such as Pressure, Volume and temperature for equations of states and form the fundamentals of first law of thermodynamics.
2. Calculate entropy for the processes, and various types of energies such as internal energy, enthalpy, Helmholtz free energy and Gibbs free energy.
3. Differentiate between ideal and non-ideal solution and estimate partial molar properties.
4. Generate Vapor Liquid Equilibrium data for ideal and non-ideal solutions and check for their consistency by various methods.
5. Find the feasibility and extent of conversion for any reaction

GRADUATE ATTRIBUTES:

- Problem analysis.
- Design/development of solutions.

QUESTION PAPER PATTERN:

The question paper will have ten questions. Each full is for 16 marks. There will be two full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer five full questions, selecting one full question from each module

Note: Use of steam tables permitted in examination and internal assessment test.

TEXT BOOKS:

1. Smith J.M. and Vanness H.C., "Introduction to Chemical Engineering Thermodynamics", 5th edn., McGraw Hill, New York, 1996
2. Rao Y.V.C., "Chemical Engineering Thermodynamics", New age International Publication, Nagpur, 2000

REFERENCE BOOK:

1. Narayanan K.V., "Text book of Chemical Engineering Thermodynamics", Prentice Hall of India Private Limited, New Delhi, 2001.

MATERIAL SCIENCE

Sub Code : 15CH44 **IA Marks : 20**
Hrs/Week : 03 **Exam Hours : 03**
Total Hrs : 50 **Exam Marks : 80**

Credits: 03

COURSE OBJECTIVES: The students will be able

1. Understand concepts on properties and selection of metals, ceramics, and polymers for design and manufacturing.
2. Study variety of engineering applications through knowledge of atomic structure, electronic structure, chemical bonding, crystal structure, x-rays and x-ray diffraction, defect structure.
3. Study Microstructure and structure-property relationships, Phase diagrams, heat treatment of steels.
4. Study detailed information on types of corrosion and its prevention.
5. Learn information on selection of materials for design and manufacturing.

Module 1	Content	Contact Hours	Blooms Taxonomy
INTRODUCTION: Introduction to material science, Classification of engineering materials, Level of structure, Structure property relationships in materials. **CRYSTAL GEOMETRY AND STRUCTURE DETERMINATION**: Geometry of crystals – the Bravais lattices, Crystal directions and planes – the miller indices, Structure determination – X –Ray diffraction – Bragg law, The powder method. **ATOMIC STRUCTURE, CHEMICAL BONDING AND STRUCTURE OF SOLIDS**: Structure of atom, Periodic table, Ionization potential, Electron		**10Hrs**	**L-1, L-2, L-3,**

affinity and Electro-negativity, Primary and secondary bonds, variation of bonding character and properties, Covalent solids, Metals and alloys, Ionic solids.		

Module 2	**Content**	**Contact Hours**	**Blooms Taxonomy**
CRYSTAL IMPERFECTIONS: Point Imperfections, Line imperfections – edge and screw dislocations, the Burgers vector, line energy of dislocations, Surface imperfections. **PHASE DIAGRAM AND PHASE TRANSFORMETIONS**: Phase rule, Single component systems, Binary phase diagrams, Lever rule, Typical phase diagrams for Magnesia-Alumina, Copper – Zinc, iron – carbon systems, Nucleation and growth, Solidification, Allotropic transformation, Cooling curve for pure iron, Iron – Carbon equilibrium diagram, Isothermal transformations (TTT curves).		**10Hrs**	**L-1, L-2, L-3,**
Module 3	**Content**	**Contact Hours**	**Blooms Taxonomy**
DEFORMATION OF MATERIALS AND FRACTURE: Elastic deformation, Plastic deformation, Creep, Visco-elastic deformation, Different types of fracture. **HEAT TREATMENT**: Annealing, normalizing, Hardening, Martempering, Austempering, Hardenability, Quenching, Tempering, Carburising, Cyaniding, Nitriding, Flame hardening.		**10Hrs**	**L-1, L-2, L-3,**
Module 4	**Content**	**Contact Hours**	**Blooms Taxonomy**
CORROSION AND ITS PREVENTION: Direct corrosion, Electro-chemical corrosion, Galvanic cells, High temperature corrosion, Passivity, factors influencing corrosion rate, Control and prevention of corrosion-modification of corrosive environment, Inhibitors, Cathodic protection, Protective coatings.		**10Hrs**	**L-1, L-2, L-3,**
Module 5	**Content**	**Contact Hours**	**Blooms Taxonomy**
TYPICAL ENGINEERING MATERIALS: Ferrous metals, Non ferrous metals and alloys – Aluminum and its alloys, Copper and its alloys, Lead and its alloys, Tin, Zinc and its alloys, Alloys for high temperature service, Ceramic materials – Structure of ceramics, Polymorphism, Mechanical, electrical and thermal properties of ceramic phases, Refractories, Glasses, abrasives, Organic materials – Mechanism of polymerization, Additives to polymers, Plastics, fibres and elastomers, Organic protective coatings.		**10Hrs**	**L-1, L-2, L-3,**

COURSE OUTCOMES: The students are expected to do the following

1. Classify different types of engineering materials depending on structure property, crystal geometry and X-Ray diffraction.
2. Explain atomic structures, types of bonding and crystal imperfections.
3. Draw phase diagrams of different metals, TTT curves and explain deformation of materials.
4. Suggest different type of heat treatment techniques depending on the type of the material and they can analyze different types of corrosions and suggest preventive methods.
5. Select materials depending on type of application.

GRADUATE ATTRIBUTES:

- Problem analysis.
- Design/development of solutions.

QUESTION PAPER PATTERN:

The question paper will have ten questions. Each full is for 16 marks. There will be two full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer five full questions, selecting one full question from each module.

TEXT BOOKS:

1. Raghavan V., "Materials Science and Engineering – A First Course", 3rd edn., Prentice Hall of India Pvt. Ltd., New Delhi, 1996
2. Hajra Choudhury S.K., "Materials Science and Processes", Indian book distributing Co., 1982

REFERENCES:

1. Van Vlack H.L., "Elements of Material Science", 2nd edn., Addison – Wesly Publishing Company, New York, 1964

CHEMICAL TECHNOLOGY-II

Sub Code : 15CH45 **IA Marks : 20**
Hrs/Week : 03 **Exam Hours : 03**
Total Hrs : 50 **Exam Marks : 80**

Credits: 04

COURSE OBJECTIVES: Students will be able to

1. Understand the basic concepts of Industrial Processes practiced in different Organic Chemical Industries.
2. Get insight in to the safety and environmental management schemes practiced.
3. Assess different engineering problems of individual processes.
4. Understand the plant layout and equipment used in the processes.

Module 1	Content	Contact Hours	Blooms Taxonomy
OILS, FATS, WAXES, SOAPS AND DETERGENTS: Vegetable and animal oils and fats. Extraction of vegetable oils, refining of edible oils. Hydrogenation of oils, waxes and their applications. Soaps and detergents, theory of detergency. Miscellaneous concentrations. Manufacture of soaps and heavy duty detergents. Linear alkyl benzenes.		**10Hrs**	**L-1, L-2, L-3,**

Module 2	Content	Contact Hours	Blooms Taxonomy

SUGAR, STARCH AND ALLIED INDUSTRIES: Production of cane sugar. Chemistry of starch. Manufacturing of industrial starch and its applications.Fermentation industries: Production of alcohol,. Manufacture of beer, wines and liquors. Acetic acid and citric acid by fermentation.	**10Hrs**	**L-1, L-2, L-3,**

Module 3	**Content**	**Contact Hours**	**Blooms Taxonomy**
PETROLEUM INDUSTRIES AND PETROCHEMICALS: Origin and classification. Petroleum refining and processing. LPG, CNG, LNG technologies, methane, propylene, benzenes.		**10Hrs**	**L-1, L-2, L-3,**

Module 4	**Content**	**Contact Hours**	**Blooms Taxonomy**
COAL: Formation, composition and Classification of coal, mining of coal, destructive distillation of coal, coking of coal, coal tar distillation, chemicals from coal. **PULP AND PAPER INDUSTRIES:** Raw materials, manufacture of pulp, paper and structural boards. Effluent treatment appropriate for pulp and paper industries.		**10Hrs**	**L-1, L-2, L-3,**

Module 5	**Content**	**Contact Hours**	**Blooms Taxonomy**
POLYMERS AND RUBBER: Macromolecules. Polymerization. PVC, LDPE. Polypropylene. Cross-linked polymers. UF and MF. Natural rubber. Synthetic rubber and rubber compounding. Engg. applications		**10Hrs**	**L-1, L-2, L-3,**

COURSE OUTCOMES: The students are expected to understand

1. Different processes employed in industries for manufacture of various products.
2. Various equipment used.
3. Flow sheet and plant layout.
4. Material and energy balances.
5. Safety and environmental aspects.
6. Engineering problems of different processes.

GRADUATE ATTRIBUTES:

- Problem analysis.
- Design/development of solutions.

QUESTION PAPER PATTERN:

The question paper will have ten questions. Each full is for 16 marks. There will be two full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer five full questions, selecting one full question from each module.

TEXT BOOKS:

1. **Chemical Process Industries,** Shreve's, 4th Edition, McGraw Hill.
2. **Dryden – Outlines of Chemical Technology for 21st Century,** Gopal Rao & Marshall Sittig, 3rd Edition., EWP.
3. **Unit Processes in Organic Chemical Industries**, Desikan and Sivakumar (Eds.), CEDC, IITM, 1982.

REFERENCE BOOK:

1. **Encyclopedia of Chemical Technology**, Kirk and Othmer, 27 volume set, 5th Edition, Wiley, 2004.**Proce**

INSTRUMENTAL ANALYSIS

Sub Code : 15CH46 **IA Marks : 20**
Hrs/Week : 03 **Exam Hours : 03**
Total Hrs : 50 **Exam Marks : 80**

Credits: 04

COURSE OBJECTIVES: The course is designed to impart the knowledge in the field of Instrumental Analysis. The various modern analytical techniques like UV-Visible, IR, NMR, Mass, GC, HPLC, different chromatographic methods and other important topics are taught to enable the students to understand and apply the principles involved in the determination of different bulk drugs and their formulation. In addition to the theoretical aspects, the basic practical knowledge relevant to the analysis is also imparted.

Module 1	Content	Contact Hours	Blooms Taxonomy
CHROMATOGRAPHY: Classification of chromatographic methods based on the mechanism of separation. Column Chromatography: Adsorption and partition, theory, preparation, procedure and methods of detection. Thin Layer Chromatography: Theory, preparation, procedures, detection of compounds. Paper Chromatography: Theory, different techniques employed, filter papers used, qualitative and quantitative detection .Counter – current extraction, solid phase extraction techniques, gel filtration		**10Hrs**	**L-1, L-2, L-3,**

Module 2	Content	Contact Hours	Blooms Taxonomy
GAS CHROMATOGRAPHY: Introduction, fundamentals, instrumentation, columns: preparation and operation, detection, dramatization. . HPLC: Principles and instrumentation, solvents and columns, detection and applications, HPTLC: Theory and principle, instrumentation, elution techniques.		**10Hrs**	**L-1, L-2, L-3,**
Module 3	**Content**	**Contact Hours**	**Blooms Taxonomy**
SPECTROSCOPY: Introduction, electromagnetic spectrum, absorbance laws and limitations, instrumentation-design and working principle, chromophore concept, auxochromes, Wood-Fisher rules for calculating absorption maximum, applications of UV-Visible spectroscopy . IR spectroscopy: Basic principles-Molecular vibrations, vibrational frequency, factors influencing vibrational frequencies, sampling techniques, instrumentation, interpretation of spectra, FT-IR, theory and applications.		**10Hrs**	**L-1, L-2, L-3,**
Module 4	**Content**	**Contact Hours**	**Blooms Taxonomy**
MASS SPECTROSCOPY: Theory, ionization techniques: electron impact ionization, chemical ionization, field ionization, fast atom bombardment, plasma desorption, fragmentation process: types of fission, resolution, GC/MS, interpretation of spectra and applications for identification and structure determination.		**10Hrs**	**L-1, L-2, L-3,**

Module 5	Content	Contact Hours	Blooms Taxonomy
NMR: Theory, instrumentation, chemical shift, shielding and de-shielding effects, splitting of signals, spin-spin coupling, proton exchange reactions, coupling constant (J), nuclear over Hauser effect (NOE), 13CNMR spectra and its applications, 2D-NMR, COSY and applications		**10Hrs**	**L-1, L-2, L-3,**

COURSE OUTCOME: The appreciable knowledge will be gained by the students in the Modern Analytical Techniques and can apply the theories involved in the Analysis of various bulk drugs and their formulations. The students will also be in a position to apply their knowledge in developing the new methods for the determination and validate the procedures.

GRADUATE ATTRIBUTES:

- Problem analysis.

- Design/development of solutions.

QUESTION PAPER PATTERN:

The question paper will have ten questions. Each full is for 16 marks. There will be two full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer five full questions, selecting one full question from each module.

TEXT BOOKS

1) Instrumental Methods of Chemical Analysis by B.K Sharma
2) Organic spectroscopy by Y.R Sharma

REFERENCE BOOKS:

1) Vogel's Text book of Quantitative Chemical Analysis by A.I.
2) Organic spectroscopy by William Kemp

CHEMICAL ENGINEERING DRAWING LAB

Sub Code : 15CHL47 **IA Marks : 20**
Hrs/Week : 1 I + 2 L **Exam Hours : 03**
Total Hrs : 42 **Exam Marks : 80**

Credits: 02

	Content	Contact Hours	Blooms taxonomy
SECTIONAL VIEWS: Representation of the sectional planes, Sectional lines and hatching, selection of section planes and types of sectional views. Equipment and piping symbols		**04Hrs**	

	Content	Contact Hours	Blooms taxonomy
PROPRTIONATE DRAWINGS Vessels components: Vessel openings, Manholes, Vessel enclosures, Vessel support, Jackets, Shell and tube heat exchanger, Reaction vessel and different types of Evaporators. P & I Diagrams		**18rs**	

	Content	Contact Hours	Blooms taxonomy
ASSEMBLY DRAWINGS: **Joints:** Cotter joint with sleeve, Socket and Spigot joint, Flanged pipe joint, Union joint, Stuffing box and Expansion joint (Screw type or flanged type)		**20rs**	

Note:

1. Assignments to be given to students to practice all the drawings and weightage shall be given to these assignments while awarding IA marks.
2. Minimum of Ten drawings are to be conducted.
3. Examination consists of one question on proportionate drawing (30 marks) and one question on Assembly drawing (50 marks).
4. **Examination to be conducted like other lab exams. Question paper should be prepared jointly by Internal and External examiners.**
5. Computer Aided drawing Software: Solid Edge or Equivalent Software.

TEXT BOOKS:

1. Gopal Krishna K.R., "Machine Drawing", 2nd revised edn., Sudhas stores, Bangalore, 1998
2. Bhat N.D., "Machine Drawing", 22nd edn., Charoter Publishing House, Anand, 1987
3. Joshi M.V., "Process Equipment Design", 3rd edn., Macmillan India publication", New Delhi, 1999

REFERENCE BOOKS:

1. Walas S.M., "Chemical Process Equipment", Butterworth Heinemann Pub., 1999
2. Ludwig E.E., "Applied Process Design", 3rd edn., Gulf Professional Publishing, New Delhi, 1994

MECHANICAL OPEARATIONS LAB

Sub Code : 15CHL48 **IA Marks : 20**
Hrs/Week : 1 I + 2 L **Exam Hours : 03**
Total Hrs : 42 **Exam Marks : 80**

Credits: 02

Experiments based on the following topics,

1. Ball mill
2. Batch sedimentation
3. Free settling
4. Drop weight crusher
5. Screen effectiveness
6. Sieve analysis
7. Jaw crusher
8. Leaf filter
9. Air elutriation
10. Air permeability
11. Grindability index
12. Gyratory crusher
13. Froth floatation
14. Plate and frame filter press
15. Cyclone separator

Minimum of 10 experiments are to be conducted