ENGINEERING MATHEMATICS IV [CORE]
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-IV
COMMON TO ALL BRANCHES

Subject Code	**: 15MAT41**	**IA Marks**	**: 20**
No. of Lecture Hours/Week	**: 04**	**Exam Marks**	**: 80**
Total No. of Lecture Hours	**: 50**	**Exam Hours**	**: 03**

CREDITS- 04

Course Objectives: This course enables students to

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Module-2		
Module-3		
Module-4		
Module-5		

Course Outcomes: At the end of the course students are able

Graduate Attributes (as per NBA)

Question paper pattern:

- The question paper will have Ten questions in total
- Each full question consists of 16 marks.
- There will be 2 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 5 full questions, selecting one full question from each module.

Text Books:

Reference Books:

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 Film boiling, Condensation - Film and Drop wise condensation, Nusselts equations. **HEAT TRANSFER EQUIPMENT**: Double pipe heat exchangers, Shell and		**10Hrs**	**L-1, L-2, L-3**

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.
   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 4	**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.

TECHNOLOGY OF INTERMEDIATE PETROCHEMICALS [D. C]

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-IV

Subject Code	**: 15PC44**	**IA Marks**	**: 20**
No. of Lecture Hours/Week	**: 04**	**Exam Marks**	**: 80**
Total No. of Lecture Hours	**: 50**	**Exam Hours**	**: 03**

CREDITS- 04

Course Objectives: This course will enable students to expose to process industries of engineering importance

- Able to identify unit operations & unit process involved
- Able to understand lay out of material flow diagrams
- Terminology of equipment's employed
- Identify problems associated & involved at manufacturing
- Identify feed stocks & by-products involved at manufacturing activities.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Petrochemicals – Definition, Petrochemical Industries in India, Petrochemical Industry Characteristics, Principal raw materials. **Petroleum Industries –** Origin of petroleum, Composition of crude petroleum, Processing of crude petroleum, Petroleum refinery products.	10	L1, L2
Module-2		
Fertilizers – Ammonia, Urea, Ammonium chloride, Ammonium nitrate, Ammonium phosphate, Ammonium sulphate, DAP. **Coal Chemicals –** Classification of coals, Destructive of coal, Coking of coal, Coal tar distillation and Chemicals from coals.	10	L2,L3
Module-3		
Chemicals from C_1 Compounds - Manufacture of methanol, Formaldehyde, Trichloroethylene, Perchloroethylene. **Chemicals from C_2 Compounds –** Ethylene and Acetylene via steam cracking of hydrocarbons, Ethylene dichloride production, Vinyl chloride production via acetylene – HCl reaction.	10	L2, L3

Module-4		
Chemical from C_3 Compounds – Production of Isopropyl alcohol by indirect hydration of propylene, Cumene (Isopropyl benzene) via propylene alkylation of benzene, Production of Acrylonitrile from propylene ammonia oxidation method, Production of Isoprene from propylene dimer. **Chemical from C_4 Compounds and Aromatics –** Production of Butadine via dehydrogenation of butane, Oxydehydrogenation versus straight dehydrogenation, Synthetic chemicals and intermediates from aromatics, Phenol from toluene oxidation.	10	L1, L2, L3
Module-5		
Fermentation Industries – Production of alcohol, Distilled liquors, Acetic acid and Citric acid. **Metallurgical Industries –** Pig iron production, Flow scheme for steel manufacture, Purification of alumina from bauxite by Bayer process, Flow scheme for copper ore concentrate.	10	L3, L4

Course Outcomes: After studying this course, students will be able to:

- Identify raw materials, by-products operations & processes associated
- Process parameters & Safety measures associated during manufacturing
- Understand importance of process industry in nation building
- Engineering problems involved at manufacturing activities

Graduate Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design/development of solutions (Partly)
- Interpretation of data.

Question paper pattern:

- The question paper will have Ten questions in total
- Each full question consists of 16 marks.
- There will be 2 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 5 full questions, selecting one full question from each module.

Text Books:

1. **Petrochemicals,** B.K. Bhaskar Rao, CRC Press,1990.
2. **Chemicals from Petroleum,** A.L. Waddams, 2nd Edition, ELBS, London, 1970.

Reference Books:

1. **Dryden's Outlines of Chemical Technology,** Gopal Rao M and Marshall Sittig, 3rd Edition, East-West Press, 1997.
2. **Chemical process industries,** 5th edition, Shreve and Austin, McGraw Hill, 1984.
3. **Chemical Technology,** G.N. Pandey, 3rd Edition, Vikas Publishing House Pvt. Ltd., 1977.

4. **Chemical Technology,** Mukhlyonov, Mir Publications, 1982.

PETROLEUM REFINERY ENGINEERING [D.C] **[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]** **SEMESTER-IV**			
Subject Code	**: 15PC45**	**IA Marks**	**: 20**
No. of Lecture Hours/Week	**: 04**	**Exam Marks**	**: 80**
Total No. of Lecture Hours	**: 50**	**Exam Hours**	**: 03**
CREDITS- 04			
Course Objectives: This course will enable students to • Fundamental and methodologies in the petroleum refining processes • Concepts of petrochemicals, Testing methods and Crude treatment methods.			
Modules		**Teaching Hours**	**Revised Bloom's Taxonomy (RBT)**
Module-1			
Indian Petroleum Industry: Prospects & Future. Major companies. World production, Markets, Offshore and onshore, Oil well technology. **Composition Of Crude:** Classification. Evaluation of petroleum. UOP-k factor. TBP analysis. EFV analysis. Average boiling point. ASTM curves. Thermal properties of petroleum fractions.		10	L1, L2
Module-2			
Product Properties And Test Methods: Gas. Various types of gas and LPG. Reid vapour pressure analysis. Gasoline and naptha. Octane No. Oxidation stability. Additives for gasoline. Kerosene. Characterization for flash point or fire point, volatility, burning qualities etc, Diesel, octane testing, viscosity etc. Grades of diesels e.g. HSD, LDO. Diesel additives. Lube oils : Types, tests-carbon residue and viscosity index.		10	L1, L2
Module-3			
Crude Pretreatment: Pumping of crude oils. Dehydration of crude by chemical, gravity, centrifugal, electrical de-salter and comparision of each. Heating of crude- heater, different types of pipe still heaters including box type, cylindrical etc. Crude distillation, arrangement of towers for various types of reflux. Design aspects for atmospheric and vacuum column. Atmospheric distillation distillation unit: internals and operational.		10	L1, L2

Module-4		
Treatment Techniques: Types of impurities present and various desulfurisation processes. Production and treatment of LPG. LNG technology. Sweetening operations for gases including merox, ethanolamine, copper chloride, stertford etc. Catalytic de sulphonisation. Treatment of kerosene, De- aromatisation and merox. Treatment of diesel, naptha: desulpurisation by hydrogen and catalysts. Treatment of lubes: sulphuric acid, clay treatment, solvent treatmentphenol, furfural. **Thermal Processes:** Thermal cracking reactions- theory of thermal cracking. Properties of cracked materials and factors influencing the properties of cracked materials. Visbreaking, dubbs two coil cracking process.	10	L1, L2
Module-5		
Catalytic Cracking: Comparision of thermal and catalytic cracking. Carbonium ion chemistry. Feedback requirements. Cracking conditions. Commercial cracking analysis. Various catalytic cracking processes. Fixed bed crackers. Moving bed crackers. Fluid catalytic cracking-flexi cracking-ortho-flow reactor. Theory of coking: various types of coking processes. Delayed coking, fluid coking, contact coking, flexi coking. Naptha cracking, naptha cracking for ethylene as feed selection and gas yield. Hydro cracking. Theory of hydro cracking. Catalysts for hydro cracking. **Catalystic Reforming:** Theory of reforming. Factors influencing reforming, reforming catalysts, feedstock requirements. Plat-forming, isoplus hondriforming, refining forming, power forming and flexi forming etc.	10	L1, L2
Course Outcomes: At the end of the course students are able understand the unit process involved in the petroleum refining process.		
Graduate Attributes (as per NBA) • Engineering Knowledge • Problem Analysis • Design/development of solutions (Partly) • Interpretation of data.		
Question paper pattern: • The question paper will have Ten questions in total • Each full question consists of 16 marks. • There will be 2 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 5 full questions, selecting one full question from each module.		
Text Books: 1. **Petroleum Refinery Engineering**, Nelson, 4th Edition, McGraw Hill, 14th Reprint, 1982. 2. **Modern Petroleum Refining Processes,** Bhaskara Rao, 3rd Edition, Oxford & IBH Publication, Reprint, 1999.		

Reference Books:

1. **Petroleum Refining Technology,** Ram Prasad, I Edition, Khanna Publishers, 2000.
2. **Challenges in Crude Oil Evaluation,** Nagnal J.M., Gate, McGraw Hill, 1996.
3. **Petroleum Processing,** Bland W.F. and Davidson R.L. McGraw Hill, 1967.

RENEWABLE ENERGY RESOURCES & SYSTEMS [FC]
[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]
SEMESTER-IV

Subject Code	**: 15PC46**	**IA Marks**	**: 20**
No. of Lecture Hours/Week	**: 04**	**Exam Marks**	**: 80**
Total No. of Lecture Hours	**: 50**	**Exam Hours**	**: 03**

CREDITS- 04

Course Objectives: This course enables students to

- Provide an overview of the promising areas of new and renewable sources of energy.
- Provide analysis of energy conversion, utilization and storage for renewable technologies.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Introduction: Current energy requirements, growth in future energy requirements, Review of conventional energy resources- Coal, gas and oil reserves and resources, Tar sands and Oil Shale, Nuclear energy Option.	10	L1, L2
Module-2		
Solar Energy: Solar radiation: measurements and prediction. Solar thermal collectors- flat plate collectors, concentrating collectors. Basic theory of flat plate collectors, solar heating of buildings, solar still, solar water heaters, solar driers; conversion of heat energy in to mechanical energy, solar thermal power generation systems. Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Photovoltaic applications : battery charger, domestic lighting, street lighting, water pumping, power generation schemes.	10	L1, L2, L3
Module-3		

Wind Energy: Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, Betz limit, WECS: classification, characteristics, and applications	10	L1, L2, L3

Module-4		
Ocean Energy: Ocean energy resources- ocean energy routes - Principles of ocean thermal energy conversion systems- ocean thermal power plants- Principles of ocean wave energy conversion and tidal energy conversion.	10	L1, L2, L3
Module-5		
Other Sources: Hydropower, Nuclear fission and fusion-Geothermal energy: Origin, types of geothermal energy sites, site selection, geothermal power plants; Magneto-hydro-dynamic (MHD) energy conversion.	10	L1, L2
Course Outcomes: At the end of the course students are able to understand of environmental consequences of energy conversion and how renewable energy can reduce air pollution and positively affect the global climate change.		
Graduate Attributes (as per NBA) • Engineering Knowledge • Problem Analysis • Design/development of solutions (Partly) • Interpretation of data.		
Question paper pattern: • The question paper will have Ten questions in total • Each full question consists of 16 marks. • There will be 2 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 5 full questions, selecting one full question from each module.		
Text Books: 1. Non-Conventional Energy Sources, G.D. Rai, 4th Edition, Khanna Publications, Second Reprint, 1997.		
Reference Books: [1] D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000. [2] C. S. Solanki, "Solar Photovoltaics: Fundamental Applications and Technologies, Prentice Hall of India, 2009. [3] L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990. [4] D. A. Spera, Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press. [5] S.P. Sukhatme, Solar Energy: principles of Thermal Collection and Storage, Tata McGraw-Hill (1984).		

PETROCHEMICAL ENGG. DRAWING LAB
[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]
SEMESTER-IV

Laboratory Code	**: 15PCL47**	**IA Marks**	**: 20**
No. of Lecture Hours/Week	**1 Hr. Tutorial(Instructions) + 2 hours Laboratory**	**Exam Marks**	**: 80**
		Exam Hours	**: 03**

CREDITS- 02

Course Objectives: This laboratory course enables students to get

- Practical experience in design and parts of equipment's.
- Assembly of joints

Laboratory Experiments: Note:	**Revised Bloom's Taxonomy (RBT) Level**
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. Examination consists of one question on proportionate drawing (30 marks) and one question on Assembly drawing (50 marks). 3. Examination to be conducted like other lab exams. Question paper should be prepared jointly by Internal and External examiner. 4. Computer Aided drawing Software: Solid Edge or Equivalent Software.	
SECTIONAL VIEWS: Representation of the sectional planes, Sectional lines and hatching, selection of section planes and types of sectional views.	L1, L2
PROPRTIONATE DRAWINGS Equipment and piping symbols, 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	L1, L2, L3
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)	L1, L2, L3

Course Outcomes: on completion of this laboratory course, the students will be able to:

- Assemble simple engineering items
- Study Terminology Drawing
- Various types of lines Scales sections used at drawing

Graduate Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design/development of solutions (Partly)

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- Students are allowed to pic one experiment from the lot.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and 15% marks allotted to the procedure part to be made zero.

Reference Books:

1. Gopal Krishna K.R., "Machine Drawing", 2nd revised edn., Sudhas stores, Bangalore, 1998

2. Bhat N.D., "Machine Drawing", 22ndedn., Charoter Publishing House, Anand, 1987
3. Joshi M.V., "Process Equipment Design", 3rdedn., Macmillan India publication", New Delhi, 1999

4. Walas S.M., "Chemical Process Equipment", Butterworth Heinemann Pub., 1999
5. Ludwig E.E., "Applied Process Design", 3rdedn., Gulf Professional Publishing, New Delhi, 1994

HEAT TRANSFER LAB
[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]
SEMESTER-IV

Laboratory Code	**: 15PCL48**	**IA Marks**	**: 20**
No. of Lecture Hours/Week	**1 Hr. Tutorial(Instructions) + 2 hours Laboratory**	**Exam Marks**	**: 80**
		Exam Hours	**: 03**

CREDITS- 02

Course Objectives: This course enables: To train the students on different types of heat transfer equipments.

Laboratory Experiments: Minimum of 10 experiments are to be conducted	**Revised Bloom's Taxonomy (RBT) Level**
1. Natural Convection in Bare and Finned tube	
2. Horizontal Shell and tube Heat exchanger	
3. Helical Coil Heat exchanger	
4. Vertical Shell and tube Heat exchanger (Condenser)	
5. Double Pipe Heat Exchanger	
6. Transient Heat Conduction	
7. Natural Convection	
8. Heat Transfer in Fluidized Beds	
9. Single stage Evaporator	
10. Heat Transfer in Packed Beds	
11. Determination of Insulation Thickness	
12. Heat Transfer in Agitated Vessels	

Course Outcomes: At the end of the course:
Student should be able to calculate heat transfer by conduction, different types of convection Using classical models for these phenomena.

Graduate Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design/development of solutions (Partly)

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- Students are allowed to pic one experiment from the lot.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and 15% marks allotted to the procedure part to be made zero.

Reference Books:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 6th Edn., McGraw-Hill, 2001.