B.TECH CHEMICAL

DEGREE IN CHEMICAL ENGINEERING

PROPOSED TEACHING SCHEME

Semester - V

SR NO	SUBJECT	TEACHING SCHEME(HOURS)			CREDITS
		THEORY	TUTORIAL	PRACTICAL	
1	Mass Transfer Operation – I	3	0	3	6
2	Mechanical Operation	3	0	3	6
3	Chemical Engineering Thermodynamics-II	3	1	0	4
4	Instrumentation & Process Control	3	0	3	6
5	Management - II	2	0	0	2
6	Fundamentals of Chemical Engg Unit Operations (Institute Elective - II)	4	0	2	6
	TOTAL	**18**	**1**	**11**	**30**

* IndustrialTraining of 2 to4 weeks is compulsory & it is a part of Curiculum.

Training can be arranged in vacation period at the end of 5th & 6th semester and will be evaluted at sem 7th.

SEMESTER: V CHEMICAL ENGINEERING

Subject Name: **Chemical Engineering Thermodynamics – II**
Subject Code: **150503**

Teaching Scheme				Evaluation Scheme		
Theory	**Tutorial**	**Practical**	**Total**	**University Exam (Theory) (E)**	**Mid Sem Exam (Theory) (M)**	**Internal Assessment (I)**
3	1	0	4	70	30	50

Sr. No.	**Course content**
1.	**Thermodynamic Properties of Fluids:** Partial Molar properties, Mathematical model for the chemical potential, Ideal and non-ideal solutions, Fugacity, Pure component fugacity, Fugacity coefficient and its evaluation, Effect of Pressure an Temperature on Fugacity, Fugacity of mixtures, Gibb's Duhemn theorem, Composition in phase equilibrium, Heat of mixing and enthalpy concentration diagrams, Excess properties of mixtures.
2.	**Phase Equilibrium:** Criteria of Phase equilibrium, Duhemn theorem, VL Equilibrium idealization, Phase diagram for miscible systems, Immiscible systems, Partial miscible systems, Testing of VLE data, Gibbs Duhemn Equation, Van Laar equation, Margules equation, Evaluation of various constants, Redlich Kwong equation, Modified forms, Excess properties of mixtures, Qualitative treatment for phase behavior at low pressures, *P-x*, y, *T-x, y*, *x-y* diagrams, Qualitative treatment for phase behavior at high pressures, Retrograde condensation, V-L equilibrium of ideal and non-ideal solutions, Henry's Law, Raoult's Law, Positive and negative deviations, Constructions of various diagram from data, Quantitative treatment for phase behavior at high pressures, Evaluation of K and construction of K-charts, Non ideal system, Evaluations of activity coefficient and fugacity coefficient, Dew point and bubble point calculations, BUBLP, DEWP, BUBLT and DEWT calculations, P-T Flash calculations, Adiabatic Flash calculations, Block diagrams of these calculations.
3.	**Chemical Reaction Equilibria:** Criteria of chemical reaction equilibrium, Equilibrium extent of reaction, Equilibrium constant, Effect of temperature and pressure on K, Evaluation of K by various methods, Evaluation of equilibrium extent of reaction for exothermic, endothermic, reversible, irreversible reactions and various combinations. Thermodynamic analysis of some important industrial reactions, Liquid phase and heterogeneous reactions, Adiabatic reactions, Multireaction equilibria.

Reference Books:

1. Smith J.M, Van Ness H.C., Abbott M. M, "Introduction to Chemical Engineering Thermodynamics", the McGraw Hill Companies, Inc., USA, 7th Ed., 2005.
2. Elliot J. R. and Lira C.T., "Introductory Chemical Engineering Thermodynamics", Prentice Hall, 1999.
3. Hougen O.A., Watson K.M., and Ragatz R.A., “Chemical Process Principles Part-II” Thermodynamics, John Wiley 1970.
4. Perry’s chemical engineers handbook, 7th edition, McGraw-Hill, USA, 2000.

SEMESTER: V CHEMICAL ENGINEERING

Subject Name: **Fundamentals of Chemical Engineering Unit Operations (Institute Elective - II)**

Subject Code: **150505**

Teaching Scheme				Evaluation Scheme		
Theory	**Tutorial**	**Practical**	**Total**	**University Exam (Theory) (E)**	**Mid Sem Exam (Theory) (M)**	**Internal Assessment (I)**
4	0	2	6	70	30	50

Sr. No.	**Course content**
1.	**Introduction:** Definition & types of Unit operations.
2.	**Fluid Flow Operation:** Types of fluids, Continuity equation, Bernoulli's equation, Various types of Pumps, Flow meters & valves, Piping.
3.	**Mechanical Operation:** Size reduction equipments, Filters, Centrifuges, Cyclones, Thickeners.
4.	**Heat Transfer Operation:** Mode of heat transfer, Definition of conduction, Convection & radiation, Condensation & boiling, Shell & tube heat exchanger & Evaporators.
5.	**Mass Transfer Operations:** Introduction of mass transfer operations like distillation, Extraction, absorption, Drying, Humidification, Crystallization, Mass transfer equipments like cooling towers, Tray drier and distillation column.

Practical and Term Work:

Experiments based on the above topics for the testing & identification should be given to the students.

Reference Books:

1. Unit Operations of Chemical Engg. By W.L. McCabe, J. C. Smith & Harriott, 6th Edition Mc-Graw Hill International.
2. "Chemical Engineering", Volume-1 & 2, 4th edition by Coulson & Richardson.
3. Unit Operation by Brown & Associates.
4. Perry's Chemical Engineers handbook, 7th edition by Perry & Green, Mc-Graw Hill international.

SEMESTER: V CHEMICAL ENGINEERING

Subject Name: **Instrumentation & Process Control**
Subject Code: **150504**

Teaching Scheme				Evaluation Scheme		
Theory	**Tutorial**	**Practical**	**Total**	**University Exam (Theory) (E)**	**Mid Sem Exam (Theory) (M)**	**Internal Assessment (I)**
3	0	3	6	70	30	50

Sr. No.	Course content
1.	**Introduction of Process Control :** Steady state system, Process control, Feedback control, Transient response, Proportional control, Integral control, Block diagram, Parts of control system.
2.	**Laplace Transforms:** Definition, Transforms of simple functions, Ramp functions, Sine functions, Solutions of differential equations. Inversions of transform function by partial fractions, qualitative nature of solutions, Final value and initial value theorems, Translation of transforms, Transforms of unit impulse functions, Transforms of integral.
3.	**Response of First Order Systems:** Mercury thermometer, Transient response of step functions, Sinusoidal input, Impulse functions.
4.	**Physical Examples of First Order Systems:** Liquid level, Mixing process, RC circuit, linearization.
5.	**Response of First Order System in Series:** Non-interacting system of liquid level, Generalization of several non-interacting systems in series, Interacting systems.
6.	**Second Order Systems:** Development of transfer functions, Damped vibrator, Liquid manometer, Thermometer in thermo pocket, Step response & impulse response for zeta<1, zeta>1&=1, Overshoot, Decay ratio, Rise time, Response time, Period of oscillation, Natural period of oscillation, Sinusoidal response, Transportation lag.
7.	**The Control Systems:** Block diagram, Negative and positive feedback, Servo problem v/s regulator problems, Development of block diagrams, Process measuring element, Controller, Final control

	element.
8.	**Controllers and Final Control Elements:** Control valve, Proportional controlling, On-off control, Proportional integral (PI) control, Proportional derivative (PD) control, Proportional integral derivative (PID) control, Motivation for addition of integral and derivative modes, Block diagram of chemical reactor control system.
9.	**Closed Loop Transfer Functions:** Standard block diagram symbols, Overall transfer function for single loop system, Overall transfer function for change in load, Overall transfer function for multiloop control system.
10.	**Transient Response of Simple Control Systems:** Proportional control for Set point change (Servo Problem), Proportional control for load change (Regulator Problem), Proportional integral control for load change, Proportional Integral control for set point change, Proportional control for system with measurement lag.
11.	**Stability:** Concept of stability, Definition of stability (linear system), Stability criterion, Characteristic equation, Routh test for stability, Routh array theorems of rough test, Nyquist stability criterion.
12.	**Frequency Response analysis:** Fortunate circumstances, Transportation lag, Bode diagrams, First order system, First order system in series, Graphical rules for Bode diagrams.
13.	**Controller Mechanism:** Actual v/s Ideal controller, Pneumatic controller mechanism of proportional control, PI control, PD control, PID control.
14.	Control valve characteristics.
15.	P & I Diagrams (Piping & Instrumentation diagram): Symbols, P&I Diagram of reactors, Distillation column, Shell & tube heat exchanger, etc.
16.	**Introduction of Process Measurement:** Elements of instruments, Parts of instruments, Static and dynamic characteristics.
17.	**Temperature Measurement:** Scales, Expansion thermometers like constant volume gas, Mercury in glass, Bimetallic, Filled system thermometer like pressure spring thermometer, Static accuracy of thermometer, Response of thermometer, Dip effect in thermometer, Errors in thermometer of liquid and gas filled type like cross ambient effect, Head effect, Methods of compensation, Thermoelectric temperature measurement: Thermo couples, Laws of thermo electricity, Pyrometers: Laws of radiation, Radiation energy distribution, Radiation receiving element, Radiation pyrometer, Photo electric pyrometers, Optical pyrometers, Errors in optical pyrometers.
18.	**Pressure Measurement:** Liquid column manometer, Enlarged lag manometer, Inclined tube manometer, Ring

	manometer, Tilting U tube manometer, Bourdon gauge, Bellows, Bellows differential pressure gauge, Vacuum Measurement: Ionization gauge, Pirani vacuum gauge, Thermocouple vacuum gauge.
19.	**Liquid Level Measurement:** Direct measurement, Float and tap, Float and shaft, Hydraulic remote transmission, Bubbler system, Diaphragm & air trap system, Differential pressure manometer, Float and spring pneumatic balance, Displacement float, Magnetic float gauge.
20.	**Flow Measurement:** Head flow meter, Orifice plate, Flow nozzle, Venturi tube pitot tube, Differential pressure meter, Electric type head flow meter, Bellows type meter, Rotameter, Piston type area meter, Positive displacement meter.

Practical and Term Work:

Experiments based on the above topics.

Reference Books:

1. "Process System Analysis & Control", Coughanower and Kappel, Mc-Graw Hill Book Company.
2. "Process Control", A. Pollard, Hoinemanm Educational Books London.
3. "Industrial Instrumentation", Donald .P. Eckman, John Wiley & Sons Inc, New York.
4. Automatic Process Control", Donald .P. Eckman.
5. Applied Instrumentation for process industries (Gulf Published company Vol.- 1,2,3,4 by W.C. Andrews.

SEMESTER: V CHEMICAL ENGINEERING

Subject Name: **Mass Transfer Operation-I**
Subject Code: **150501**

Teaching Scheme				Evaluation Scheme		
Theory	**Tutorial**	**Practical**	**Total**	**University Exam (Theory) (E)**	**Mid Sem Exam (Theory) (M)**	**Internal Assessment (I)**
3	0	3	6	70	30	50

Sr. No.	**Course content**
1.	Introduction to mass transfer operations.
2.	**Molecular and Eddy Diffusion in fluids:** Definition of molecular and eddy diffusivity ,Ficks first law, Concept of N &J Flux, Steady state molecular diffusion in fluids at rest and in laminar flow, Diffusivity of gases, Diffusivity of liquids, Applications of molecular diffusion.
3.	**Inter Phase Mass Transfer:** Concept of overall mass transfer coefficient, Concept of effective diffusivity. Film penetration and surface renewal theory.
4.	**Gas Absorption:** Solubility of gases in liquids, Ideal and non-ideal solution, Choice of solvent for absorption, Material balance and liquid gas ratio for absorption and stripping, Counter current multi stage operation (isothermal), Continuous contact equipments, Introduction to absorption with chemical reaction, Multi component absorption and non isothermal absorption, Concept of HETP and HTU, NTU and jh factor, Industrial absorbers.
5.	**Equipments for Gas Liquid Operations:** Sparged vessels, Agitated vessels, Venturi scrubber, Spray tower, Tray Towers: Tray tower internals, Different types of trays, Weirs, Downcomers and criteria of their selection, Flooding, Loading, Coning, Weeping & dumping in tray tower, Packed Towers: Packed tower internals, Different types of packings and their selection criteria, Different types of liquid distributors, Redistributors, Packing supports, Mist eliminators and packing restrainers and their selection criteria, Flooding, Loading and channeling in packed tower, Tray tower vs. Packed tower.

6.	**Liquid-Liquid Extraction and Leaching:** Ternary liquid- liquid equilibrium and tie line data choice of solvent, Single stage & multistage extraction, Co-current and cross current extraction, Continuous counter current multistage extraction with and without reflux, Theory & performance of continuous contact equipments, Single stage & multistage equipments, Applications of liquid-liquid extraction, Steady state and unsteady state leaching equipments, Single stage leaching, Multistage cross current and counter current leaching, Rate of leaching, Recovery of solvent vapors, Application of leaching.
7.	**Crystallization:** Saturation, Nucleation, Crystallization rate, Effect of temperature on solubility, Caking of crystals, Batch crystallizers, Continuous crystallizer.

Practical and Term Work:

Experiments based on the above topics.

Reference Books:

1. "Mass transfer operation"by R.E.Treybal, Mc-Graw Hill international.
2. "Mass Transfer" by Sherwood,Pigford & Wilke, Mc-Graw Hill international.
3. "Chemical Engineering", Volume-2 ,4th edition by Coulson & Richardson.
4. Perry's Chemical Engineers handbook, 7th edition by Perry & Green, Mc-Graw. Hill international.
5. Unit Operations of Chemical Engg. By W.L. McCabe, J. C. Smith & Harriott, 6th edition Mc-Graw Hill international.

SEMESTER: V CHEMICAL ENGINEERING

Subject Name: **Mechanical Operation**
Subject Code: **150502**

Teaching Scheme				Evaluation Scheme		
Theory	**Tutorial**	**Practical**	**Total**	**University Exam (Theory) (E)**	**Mid Sem Exam (Theory) (M)**	**Internal Assessment (I)**
3	0	3	6	70	30	50

Sr. No.	Course content
1.	**Solids and Its Flow Properties:** Characterization of solid particles, Mixed particles sizes and analysis, Screen analysis, properties of particulate masses, Mixing of solids, Mixer for cohesive solids, Mixer for free flowing solids.
2.	**Size Reduction, Enlargement, Screening:** Principles of comminution, Rittinger's and kick's laws, Bond's crushing law and work index, Size reduction equipments, crushers, grinders, Ultra fine grinders, Cutting machines, Open circuit and closed circuit operation, Screening equipment, Comparison of ideal and actual screens, Screen effectiveness.
3.	**Fluidization and Conveying:** Conditions for Fluidization, Types of fluidization, Applications of fluidization, Slurry and pneumatic transport, Conveyers.
4.	**Filtration and Sedimentation :** Cake filters, Filter press, Shell and leaf filters, Discontinuous vacuum filters, Continuous vacuum filters, Centrifugal filters, Filter media, Filter aids, Principles of cake filtration, Clarifying filters, Gravity classifiers, Sink and float method, Differential settling methods, Clarifiers and thickeners, Batch sedimentation, Rate of sedimentation, Thickeners, sedimentation zones in continuous thickeners, Cyclones, Hydrocyclones, Cenrifuges.
5.	**Mixing and Agitation:** Different types of agitators and their selection criteria, Calculation of power required for agitation, Scale up of agitated vessel, Static mixers.

Practical and Term Work:

Experiments based on the above topics for the testing, identification, analysis and preparations, etc. should be given to the students.

Reference Books:

1. Unit Operations of Chemical Engg. By W.L. McCabe, J. C. Smith & Harriott, 6th Edition Mc-Graw Hill international.
2. Introduction to Chemical Engineering by W. L. Badger & J.T. Banchero.
3. "Chemical Engineering", Volume-2, 4th edition by Coulson & Richardson.
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