DR. A.P.J. ABDUL KALAM TECHNICAL

UNIVERSITY, LUCKNOW

Evaluation Scheme & Syllabus for

B. Tech.

(All Branches)

AS PER AICTE MODEL CURRICULUM

(Effective from the Session: 2018-19)

B. Tech 1st Year (All branches except Bio Technology and Agriculture

Engg.) Structure in accordance with AICTE Model Curriculum
Effective w.e.f. Academic Session 2018-19

SEMESTER - I

Sl. No.	Code	SUBJECT	PERIODS			EVALUATION SCHEME				END SEMESTER		TOTAL	CREDIT
			L	T	P	CT	TA	Total	PS	TE	PE		
3 WEEKS COMPULSORY INDUCTION PROGRAM													
1	**KAS101/ KAS102**	Physics/Chemistry	3	1	3	30	20	50	25	100	25	200	5.5
2	**KAS103**	Mathematics-I	3	1	0	30	20	50	-	100	-	150	4
3	**KEE 101/ KCS101**	Basic Electrical Engineering/Programming for Problem Solving	3	1	2	30	20	50	25	100	25	200	5
4	**KCE101/ KWS101**	Engineering Graphics & Design/Workshop Practices	1	0	4	-	-	-	25	-	25	50	3
	MOOCs (For B.Tech. Hons. Degree**)***												0
		TOTAL										600	17.5

SEMESTER II

Sl. No.	Code	SUBJECT	PERIODS			EVALUATION SCHEME				END SEMESTER		TOTAL	CREDIT
			L	T	P	CT	TA	Total	PS	TE	PE		
1	**KAS201/ KAS202**	Physics/Chemistry	3	1	3	30	20	50	25	100	25	200	5.5
2	**KAS203**	Mathematics II	3	1	0	30	20	50	-	100	-	150	4
3	**KEE201/ KCS201**	Basic Electrical Engineering/Programming for Problem Solving	3	1	2	30	20	50	25	100	25	200	5
4	**KCE201/ KWS201**	Engineering Graphics & Design/Workshop Practices	1	0	4	-	-	-	25	-	25	50	3
5	**KAS204**	Professional English	2	0	2	30	20	50	-	100	-	150	3
	MOOCs (For B.Tech. Hons. Degree**)***												0
		TOTAL										750	20.5
Mini Project or Internship (3-4 weeks) shall be conducted during summer break after II semester and will be assessed during III semester													

*** List of MOOCs (NPTL) Based Recommended Courses for first year B. Tech Students**

1. Developing Soft Skills and personality-Odd Semester-8 Weeks-3 Credits
2.Enhancing Soft Skills and personality-Even Semester-8 Weeks-3 Credits

*** AICTE Guidelines in Model Curriculum:**

After successful completion of 160 credits, a student shall be eligible to get Under Graduate degree in Engineering. A student will be eligible to get Under Graduate degree with Honours only, if he/she completes additional university recommended courses only (Equivalent to 20 credits; NPTEL Courses of 4 Weeks, 8 Weeks and 12 Weeks shall be of 2, 3 and 4 Credits respectively) through MOOCs. For registration to MOOCs Courses, the students shall follow NPTEL Site http://nptel.ac.in/ as per the NPTEL policy and norms. The students can register for these courses through NPTEL directly as per the course offering in Odd/Even Semesters at NPTEL. These NPTEL courses (recommended by the University) may be cleared during the B. Tech degree program (not necessary one course in each semester). After successful completion of these MooCs courses the students, shall, provide their successful completion NPTEL status/certificates to the University (COE) through their college of study only. The student shall be awarded Hons. Degree (on successful completion of MOOCS based 20 credit) only if he/she secures 7.50 or above CGPA and passed each subject of that Degree Programme in single attempt without any grace marks.

SEMESTER – I

PHYSICS

Module - 1 Relativistic Mechanics: *[8]*

Frame of reference, Inertial & non-inertial frames, Galilean transformations, MichelsonMorley experiment, Postulates of special theory of relativity, Lorentz transformations, Length contraction, Time dilation, Velocity addition theorem, Variation of mass with velocity, Einstein‟s mass energy relation, Relativistic relation between energy and momentum, Massless particle.

Module- 2 Electromagnetic Field Theory: *[8]*

Continuity equation for current density, Displacement current, Modifying equation for the curl of magnetic field to satisfy continuity equation, Maxwell‟s equations in vacuum and in non conducting medium, Energy in an electromagnetic field, Poynting vector and Poynting theorem, Plane electromagnetic waves in vacuum and their transverse nature. Relation between electric and magnetic fields of an electromagnetic wave, Energy and momentum carried by electromagnetic waves, Resultant pressure, Skin depth.

Module- 3 Quantum Mechanics: *[8]*

Black body radiation, Stefan‟s law, Wien‟s law, Rayleigh-Jeans law and Planck‟s law, Wave particle duality, Matter waves, Time-dependent and time-independent Schrodinger wave equation, Born interpretation of wave function, Solution to stationary state Schrodinger wave equation for one-Dimensional particle in a box, Compton effect.

Module- 4 Wave Optics: *[10]*

Coherent sources, Interference in uniform and wedge shaped thin films, Necessity of extended sources, Newton‟s Rings and its applications. Fraunhoffer diffraction at single slit and at double slit, absent spectra, Diffraction grating, Spectra with grating, Dispersive power, Resolving power of grating, Rayleigh‟s criterion of resolution, Resolving power of grating.

Module- 5Fibre Optics & Laser: *[10]*

Fibre Optics**:** Introduction to fibre optics, Acceptance angle, Numerical aperture, Normalized frequency, Classification of fibre, Attenuation and Dispersion in optical fibres. Laser: Absorption of radiation, Spontaneous and stimulated emission of radiation, Einstein‟s coefficients, Population inversion, Various levels of Laser, Ruby Laser, He-Ne Laser, Laser applications.

Course Outcomes:

1. To solve the classical and wave mechanics problems
2. To develop the understanding of laws of thermodynamics and their application in various processes
3. To formulate and solve the engineering problems on Electromagnetism & Electromagnetic Field Theory
4. To aware of limits of classical physics & to apply the ideas in solving the problems in their parent streams

Reference Books:

1. Concepts of Modern Physics - AurthurBeiser (Mc-Graw Hill)
2. Introduction to Special Theory of Relativity- Robert Resnick (Wiley)
3. Optics - Brijlal& Subramanian (S. Chand)
4. Engineering Physics: Theory and Practical- Katiyar and Pandey (Wiley India)
5. Applied Physics for Engineers- Neeraj Mehta (PHI Learning, New)
6. Engineering Physics-Malik HK and Singh AK (McGrawHill)

PHYSICS LAB

LIST OF EXPERIMENT

Any ten experiments (at least four from each group).

Group A

1. To determine the wavelength of sodium light by Newton‟s ring experiment.
2. To determine the wavelength of different spectral lines of mercury light using plane transmission grating.
3. To determine the specific rotation of cane sugar solution using polarimeter.
4. To determine the focal length of the combination of two lenses separated by a distance and verify the formula for the focal length of combination of lenses.
5. To measure attenuation in an optical fiber.
6. To determine the wavelength of He-Ne laser light using single slit diffraction.
7. To study the polarization of light using He-Ne laser light.
8. To determine the wavelength of sodium light with the help of Fresnel‟s bi-prism.
9. To determine the coefficient of viscosity of a given liquid.
10. To determine the value of acceleration due to gravity (g) using compound pendulum.

Group B

1. To determine the energy band gap of a given semiconductor material.
2. To study Hall effect and determine Hall coefficient, carrier density and mobility of a given semiconductor material using Hall effect setup.
3. To determine the variation of magnetic field with the distance along the axis of a current carrying coil and estimate the radius of the coil.
4. To verify Stefan‟s law by electric method.
5. To determine resistance per unit length and specific resistance of a given resistance using Carey Foster's Bridge.
6. To study the resonance condition of a series LCR circuit.
7. To determine the electrochemical equivalent (ECE) of copper.
8. To calibrate the given ammeter and voltmeter by potentiometer.
9. To draw hysteresis (B-H curve) of a specimen in the form of a transformer and to determine its hysteresis loss.
10. To measure high resistance by leakage method.

Reference Books

1. Practical Physics- K. K. Dey & B. N. Dutta (Kalyani Publishers New Delhi)
2. Engineering Physics-Theory and Practical- Katiyar& Pandey (Wiley India)

3. Engineering Physics Practical- S K Gupta (KrishnaPrakashan Meerut)

Course Outcomes:

1. To determine the wavelength of sodium light by Newton‟s ring experiment
2. To determine the wavelength of sodium light with the help of Fresnel‟s bi-prism
3. To determine the variation of magnetic field with the distance along the axis of a current carrying coil and estimate the radius of the coil.
4. To draw hysteresis (B-H curve) of a specimen in the form of a transformer and to determine its hysteresis loss.

CHEMISTRY

Module-1 **[08]**

Atomic and Molecular Structure:

Molecular orbital‟s of diatomic molecules. Band theory of solids. Liquid crystal and its applications. Point defects in solids. Structure and applications of Graphite and Fullerenes. Concepts of Nanomaterials and its application.

Module-2 **[08]**

Spectroscopic techniques and Applications:

Elementary idea and simple applications of Rotational, Vibrational, Ultraviolet& Visible and Raman spectroscopy.

Module-3 **[08]**

Electrochemistry

Nernst Equation and application, relation of EMF with thermodynamic functions (ΔH, ΔF and ΔS). Lead storage battery.

Corrosion; causes, effects and its prevention.

Phase Rule and its application to water system.

Module-4 **[08]**

Water Analysis; Hardness of water, Techniques for water softening (Lime-soda, Zeolite, Ion exchange resin and Reverse osmosis method).

Fuels: classification of fuels, Analysis of coal, Determination of calorific value (Bomb calorimeterand Dulong‟smethos).

Module-5 **[08]**

Polymer; Basic concepts of polymer-Blend and composites, Conducting and biodegradable polymers. Preparation and application of some industrially important polymers (Buna-S, Buna-N, Neoprene, Nylon-6, nylon-6,6 and Terylene). General methods of synthesis of organometallic compounds (Grignard reagent) and their applications.

Course Outcomes:

1. Use of different analytical instruments.
2. Measure molecular/system properties such as surface tension, viscosity, conductance of solution, chloride and iron content in water.
3. Measure hardness of water.
4. Estimate the rate constant of reaction.

Reference Books:

1. University Chemistry By B.H. Mahan
2. University Chemistry By C.N.R. Rao
3. Organic Chemistry By I.L. Finar
4. Physical Chemistry By S. Glasstone
5. Engineering Chemistry By S.S. Dara
6. Polymer Chemistry ByFre W., Billmeyer
7. Engineering ChemistryBy Satya Prakash

CHEMISTRY- PRACTICAL

LIST OF EXPERIMENTS

1. Determination of alkalinity in the given water sample.
2. Determination of temporary and permanent hardness in water sample using EDTA.
3. Determination of iron content in the given solution by Mohr‟s method.
4. Determination of viscosity of given liquid.
5. Determination of surface tension of given liquid.
6. Determination of chloride content in water sample.

7. Determination of available chlorine in bleaching powder.
8. Determination of pH by pH-metric titration.
9. Preparation of Phenol-formaldehyde and Urea-formaldehyde resin.
10. Determination of Cell constant and conductance of a solution.
11. Determination of rate constant of hydrolysis of esters.
12. Verification of Beer‟s law.

NOTE: Choice of any 10 experiments from the above. Institute can change any 02 experiments from the aforesaid experiments.

Course Outcomes:

1. Use of different analytical instruments.
2. Measure molecular/system properties such as surface tension, viscosity, conductance of solution, chloride and iron content in water.
3. Measure hardness of water.
4. Estimate the rate constant of reaction.

MATHEMATICS-I

(Common to all B. Tech. Courses except B. Tech. (Biotechnology)&B. Tech. (Agricultural Engineering)

Module 1: Matrices *[08]*

Types of Matrices: Symmetric, Skew-symmetric and Orthogonal Matrices; Complex Matrices, Inverse and Rank of matrix using elementary transformations, Rank-Nullity theorem; System of linear equations, Characteristic equation, Cayley-Hamilton Theorem and its application, Eigen values and eigenvectors; Diagonalisation of a Matrix,

Module 2: Differential Calculus- I *[08]*

Introduction to limits, continuity and differentiability, Rolle's Theorem, Lagrange's Mean value theorem and Cauchy mean value theorem, Successive Differentiation (n^{th} order derivatives), Leibnitz theorem and its application, Envelope, Involutes and Evolutes, Curve tracing: Cartesian and Polar co-ordinates

Module 3: Differential Calculus-II *[08]*

Partial derivatives, Total derivative, Euler's Theorem for homogeneous functions, Taylor and Maclaurin's theorems for a function of one and two variables, Maxima and Minima of functions of several variables, Lagrange Method of Multipliers, Jacobians, Approximation of errors.

Module 4: Multivariable Calculus-I *[08]*

Multiple integration**:** Double integral, Triple integral, Change of order of integration, Change of variables, Application: Areas and volumes, Center of mass and center of gravity (Constant and variable densities),

Module 5: Vector Calculus *[08]*

Vector differentiation: Gradient, Curl and Divergence and their Physical interpretation, Directional derivatives, Tangent and Normal planes.

Vector Integration: Line integral, Surface integral, Volume integral, Gauss's Divergence theorem, Green's theorem, Stoke's theorem (without proof) and their applications.

COURSE OUTCOMES

1. Remember the concept of matrices and apply for solving linear simultaneous equations.
2. Understand the concept of limit, continuity and differentiability and apply in the study of Rolle,s , Lagrange,s and Cauchy mean value theorem and Leibnitz theorems .
3. Identify the application of partial differentiation and apply for evaluating maxima, minima, series and Jacobians.
4. Illustrate the working methods of multiple integral and apply for finding area, volume, centre of mass and centre of gravity.
5. Remember the concept of vector and apply for directional derivatives, tangent and normal planes. Also evaluate line, surface and volume integrals.

Text Books:-

1. B. V. Ramana, Higher Engineering Mathematics, Tata Mc Graw-Hill Publishing Company Ltd., 2008.
2. B. S. Grewal, Higher Engineering Mathematics, Khanna Publisher, 2005.
3. R K. Jain & S R K. Iyenger , Advance Engineering Mathematics, Narosa Publishing House 2002.

Reference Books-

1. E. Kreyszig, Advance Engineering Mathematics, John Wiley & Sons, 2005.
2. Peter V. O'Neil, Advance Engineering Mathematics, Thomson (Cengage) Learning, 2007.
3. Maurice D. Weir, Joel Hass, Frank R. Giordano, Thomas, Calculus, Eleventh Edition, Pearson.
4. D. Poole, Linear Algebra : A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
5. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
6. Ray Wylie C and Louis C Barret, Advanced Engineering Mathematics, Tata Mc-Graw-Hill; Sixth Edition.
7. P. Sivaramakrishna Das and C. Vijayakumari, Engineering Mathematics, 1st Edition, Pearson India Education Services Pvt. Ltd
8. Advanced Engineering Mathematics. Chandrika Prasad, Reena Garg, 2018.
9. Engineering Mathemathics – I. Reena Garg, 2018.

BASIC ELECTRICAL ENGINEERING

Module - 1: DC Circuits **[08]**

Electrical circuit elements (R, L and C), Concept of active and passive elements, voltage and current sources, concept of linearity and linear network, unilateral and bilateral elements, Kirchhoff‟s laws, Loop and nodal methods of analysis, Star-delta transformation, Superposition theorem, Thevenin theorem, Norton theorem.

Module - 2: Steady- State Analysis of Single Phase AC Circuits **[10]**

Representation of Sinusoidal waveforms – Average and effective values, Form and peak factors, Concept of phasors, phasor representation of sinusoidally varying voltage and current.

Analysis of single phase AC Circuits consisting of R, L, C, RL, RC, RLC combinations (Series and Parallel), Apparent, active & reactive power, Power factor, power factor improvement. Concept of Resonance in series & parallel circuits, bandwidth and quality factor.

Three phase balanced circuits, voltage and current relations in star and delta connections.

Module - 3 : Transformers **[08]**

Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

Module –4 : Electrical machines **[08]**

DC machines: Principle & Construction, Types, EMF equation of generator and torque equation of motor, applications of DC motors (simple numerical problems)

Three Phase Induction Motor: Principle & Construction, Types, Slip-torque characteristics, Applications (Numerical problems related to slip only)

Single Phase Induction motor: Principle of operation and introduction to methods of starting, applications.

Three Phase Synchronous Machines: Principle of operation of alternator and synchronous motor and their applications.

Module –5 : Electrical Installations **[06]**

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Importance of earthing. Types of Batteries, Important characteristics for Batteries.Elementary calculations for energy consumption and savings, battery backup.

COURSE OUTCOMES

1. Apply the concepts of KVL/KCL and network theorems in solving DC circuits.
2. Analyze the steady state behavior of single phase and three phase AC electrical circuits.

3. Identify the application areas of a single phase two winding transformer as well as an auto transformer and calculate their efficiency. Also identify the connections of a three phase transformer.
4. Illustrate the working principles of induction motor, synchronous machine as well as DC machine and employ them in different area of applications.
5. Describe the components of low voltage electrical installations and perform elementary calculations for energy consumption.

Spoken Tutorial (MOOCs):

1. AC DC Circuit Analysis using NgSpice, Open Source Software (http://spokentutorial.org)

Text Books:

1. Ritu Sahdev, "Basic Electrical Engineering", Khanna Publishing House.
2. S. Singh, P.V. Prasad, "Electrical Engineering: Concepts and Applications" Cengage.
3. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill.
4. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill.

Reference Books:

1. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
2. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press.
3. V. D. Toro, "Electrical Engineering Fundamentals", Pearson India.

ELECTRICAL ENGINEERING LABORATORY

LIST OF EXPERIMENTS

Note: A minimum of ten experiments from the following should be performed.

1. Verification of Kirchhoff's laws
2. Verification of Superposition and Thevenin Theorem.

3. Measurement of power and power factor in a single phase ac series inductive circuit and study improvement of power factor using capacitor
4. Study of phenomenon of resonance in RLC series circuit and obtain resonant frequency.
5. Connection and measurement of power consumption of a fluorescent lamp (tube light).
6. Measurement of power in 3- phase circuit by two wattmeter method and determination of its power factor for star as well as delta connected load.
7. Determination of parameters of ac single phase series RLC circuit
8. To observe the B-H loop of a ferromagnetic material in CRO.
9. Determination of (i) Voltage ratio (ii) polarity and (iii) efficiency by load test of a single phase transformer
10. Determination of efficiency of a dc shunt motor by load test
11. To study running and speed reversal of a three phase induction motor and record speed in both directions.
12. Demonstration of cut-out sections of machines: dc machine, three phase induction machine, singlephase induction machine and synchronous machine.

COURSE OUTCOMES

1. Conduct experiments illustrating the application of KVL/KCL and network theorems to DC electrical circuits.
2. Demonstrate the behavior of AC circuits connected to single phase AC supply and measure power in single phase as well as three phase electrical circuits.
3. Perform experiment illustrating BH curve of magnetic materials.
4. Calculate efficiency of a single phase transformer and DC machine.
5. Perform experiments on speed measurement and reversal of direction of three phase induction motor and Identify the type of DC and AC machines based on their construction.

PROGRAMMING OF PROBLEM SOLVING

Module – 1 : (Introduction to Programming) [08]

Introduction to components of a computer system: Memory, processor, I/O Devices, storage, operating system, Concept of assembler, compiler, interpreter, loader and linker.

Idea of Algorithm: Representation of Algorithm, Flowchart, Pseudo code with examples, From algorithms to programs, source code.

Programming Basics: Structure of C program, writing and executing the first C program, Syntax and logical errors in compilation, object and executable code. Components of C language.

Standard I/O in C, Fundamental data types, Variables and memory locations, Storage classes.

Module – 2 : (Arithmetic expressions & Conditional Branching) [08]

Arithmetic expressions and precedence: Operators and expression using numeric and relational operators, mixed operands, type conversion, logical operators, bit operations, assignment operator, operator precedence and associativity.

Conditional Branching: Applying if and switch statements, nesting if and else, use of break and default with switch.

Module – 3 : (Loops & Functions) [08]

Iteration and loops: use of while, do while and for loops, multiple loop variables, use of break and continue statements.

Functions: Introduction, types of functions, functions with array, passing parameters to functions, call by value, call by reference, recursive functions.

Module – 4 : (Arrays & Basic Algorithms) [08]

Arrays: Array notation and representation, manipulating array elements, using multi dimensional arrays. Character arrays and strings, Structure, union, enumerated data types, Array of structures, Passing arrays to functions.

Basic Algorithms: Searching &Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, Notion of order of complexity.

Module – 5 :(Pointer& File Handling) **[08]**

Pointers: Introduction, declaration, applications, Introduction to dynamic memory allocation (malloc, calloc, realloc, free), Use of pointers in self-referential structures, notion of linked list (no implementation)

File handling: File I/O functions, Standard C preprocessors, defining and calling macros, command-line arguments.

COURSE OUTCOMES

1. To develop simple algorithms for arithmetic and logical problems.
2. To translate the algorithms to programs & execution (in C language).
3. To implement conditional branching, iteration and recursion.
4. To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
5. To use arrays, pointers and structures to develop algorithms and programs.

Text books:

1. Schum‟s Outline of Programming with C by Byron Gottfried, McGraw-Hill
2. The C programming by Kernighan Brain W. and Ritchie Dennis M., Pearson Education.
3. Computer Basics and C Programming by V.Rajaraman , PHI Learning Pvt. Limited, 2015.
4. Computer Concepts and Programming in C, R.S. Salaria, Khanna Publishing House
5. Computer Concepts and Programming in C, E Balaguruswami, McGraw Hill
6. Computer Science- A Structured Programming Approach Using C, by Behrouz A.
   Forouzan, Richard F. Gilberg, Thomson, Third Edition , Cengage Learning - 2007.
7. Let Us C By Yashwant P. Kanetkar.
8. Problem Solving and Program Design in C, by Jeri R. Hanly, Elliot B. Koffman,
   Pearson

   Addison-Wesley, 2006.
9. Programming in C by Kochan Stephen G. Pearson Education – 2015.
10. Computer Concepts and Programming in C by D.S. Yadav and Rajeev Khanna, New AgeInternational Publication.
11. Computer Concepts and Programming by Anami, Angadi and Manvi, PHI Publication.
12. Computer Concepts and Programming in C by Vikas Gupta, Wiley India Publication
13. Computer Fundamentals and Programming in C. Reema Thareja, Oxford Publication
14. Problem Solving and Programming in C, R.S. Salaria, Khanna Publishing House

CHEMISTRY LAB

List of Experiments (Any ten experiments (at least four from each group).

Group A

11. To determine the wavelength of sodium light by Newton‟s ring experiment.
12. To determine the wavelength of different spectral lines of mercury light using plane transmission grating.
13. To determine the specific rotation of cane sugar solution using polarimeter.
14. To determine the focal length of the combination of two lenses separated by a distance and verify the formula for the focal length of combination of lenses.
15. To measure attenuation in an optical fiber.
16. To determine the wavelength of He-Ne laser light using single slit diffraction.
17. To study the polarization of light using He-Ne laser light.
18. To determine the wavelength of sodium light with the help of Fresnel‟s bi-prism.
19. To determine the coefficient of viscosity of a given liquid.
20. To determine the value of acceleration due to gravity (g) using compound pendulum.

Group B

11. To determine the energy band gap of a given semiconductor material.
12. To study Hall effect and determine Hall coefficient, carrier density and mobility of a given semiconductor material using Hall effect setup.
13. To determine the variation of magnetic field with the distance along the axis of a current carrying coil and estimate the radius of the coil.
14. To verify Stefan‟s law by electric method.
15. To determine resistance per unit length and specific resistance of a given resistance using Carey Foster's Bridge.
16. To study the resonance condition of a series LCR circuit.
17. To determine the electrochemical equivalent (ECE) of copper.
18. To calibrate the given ammeter and voltmeter by potentiometer.
19. To draw hysteresis (B-H curve) of a specimen in the form of a transformer and to determine its hysteresis loss.
20. To measure high resistance by leakage method.

Course Outcomes:

1. To determine the wavelength of sodium light by Newton‟s ring experiment
2. To determine the wavelength of sodium light with the help of Fresnel‟s bi-prism
3. To determine the variation of magnetic field with the distance along the axis of a current carrying coil and estimate the radius of the coil.

4. To draw hysteresis (B-H curve) of a specimen in the form of a transformer and to determine its hysteresis loss.

Reference Books

1. Practical Physics- K. K. Dey & B. N. Dutta (Kalyani Publishers New Delhi)
2. Engineering Physics-Theory and PracticalKatiyar& Pandey (Wiley India)
3. Engineering Physics Practical- S K Gupta (Krishna Prakashan Meerut)

Module-1 **[08]**

Atomic and Molecular Structure:

Molecular orbital‟s of diatomic molecules. Band theory of solids. Liquid crystal and its applications. Point defects in solids. Structure and applications of Graphite and Fullerenes. Concepts of Nanomaterials and its application.

Module-2 **[08]**

Spectroscopic techniques and Applications:

Elementary idea and simple applications of Rotational, Vibrational, Ultraviolet& Visible and Raman spectroscopy.

Module-3 **[08]**

Electrochemistry

Nernst Equation and application, relation of EMF with thermodynamic functions (ΔH, ΔF and Δ S). Lead storage battery.

Corrosion; causes, effects and its prevention.

Phase Rule and its application to water system.

Module-4 **[08]**

Water Analysis; Hardness of water, Techniques for water softening (Lime-soda, Zeolite, Ion exchange resin and Reverse osmosis method).

Fuels: classification of fuels, Analysis of coal, Determination of calorific value (Bomb calorimeterand Dulong‟smethos).

Module-5 **[08]**

Polymer; Basic concepts of polymer-Blend and composites, Conducting and biodegradable polymers. Preparation and application of some industrially important polymers (Buna-S, Buna-N, Neoprene, Nylon-6, nylon-6,6 and Terylene). General methods of synthesis of organometallic compounds (Grignard reagent) and their applications.

Course Outcomes:

1. Get an understanding of the theoretical principles understanding molecular structure, bonding and properties.
2. Know the fundamental concepts of determination of structure with various techniques.
3. Know the fundamental concepts of chemistry applicable in industrial processes.

Reference Books:

1. University Chemistry By B.H. Mahan
2. University Chemistry By C.N.R. Rao
3. Organic Chemistry By I.L. Finar
4. Physical Chemistry By S. Glasstone
5. Engineering Chemistry By S.S. Dara
7. Polymer Chemistry ByFre W., Billmeyer
8. Engineering Chemistry By Satya Prakash

CHEMISTRY- PRACTICAL

LIST OF EXPERIMENTS

1. Determination of alkalinity in the given water sample.
2. Determination of temporary and permanent hardness in water sample using EDTA.
3. Determination of iron content in the given solution by Mohr‟s method.
4. Determination of viscosity of given liquid.
5. Determination of surface tension of given liquid.
6. Determination of chloride content in water sample.
7. Determination of available chlorine in bleaching powder.
8. Determination of pH by pH-metric titration.
9. Preparation of Phenol-formaldehyde and Urea-formaldehyde resin.
10. Determination of Cell constant and conductance of a solution.
11. Determination of rate constant of hydrolysis of esters.
12. Verification of Beer‟s law.

NOTE: Choice of any 10 experiments from the above. Institute can change any 02 experiments from the aforesaid experiments.

COURSE OUTCOME:

1. Use of different analytical instruments.
2. Measure molecular/system properties such as surface tension, viscosity, conductance of solution, chloride and iron content in water.
3. Measure hardness of water.
4. Estimate the rate constant of reaction.

MATHEMATICS-II

(Common to all B. Tech. Courses except B. Tech., Biotechnology and Agricultural Engineering)

Module 1: Ordinary Differential Equation of Higher Order [10]

Linear differential equation of n^{th} order with constant coefficients, Simultaneous linear differential equations, Second order linear differential equations with variable coefficients, Solution by changing independent variable, Reduction of order, Normal form, Method of variation of parameters, Cauchy-Euler equation, Series solutions (Frobenius Method).

Module 2: Multivariable Calculus-II [08]

Improper integrals, Beta & Gama function and their properties, Dirichlet's integral and its applications, Application of definite integrals to evaluate surface areas and volume of revolutions.

Module 3: Sequences and Series [08]

Definition of Sequence and series with examples, Convergence of sequence and series, Tests for convergence of series, (Ratio test, D' Alembert's test, Raabe's test). Fourier series, Half range Fourier sine and cosine series.

Module 4: Complex Variable – Differentiation [08]

Limit, Continuity and differentiability, Functions of complex variable, Analytic functions,

Cauchy- Riemann equations (Cartesian and Polar form), Harmonic function, Method to find

Analytic functions, Conformal mapping, Mobius transformation and their properties

Module 5: Complex Variable –Integration [08]

Complex integrals, Contour integrals, Cauchy- Goursat theorem, Cauchy integral formula, Taylor's series, Laurent's series, Liouvilles's theorem, Singularities, Classification of

Singularities, zeros of analytic functions, Residues, Methods of finding residues, Cauchy Residue theorem, Evaluation of real integrals of the type $\int_0^{2\pi} f(\cos\theta, \sin\theta)\, d\theta$ and $\int_{-\infty}^{\infty} f(x)\, dx$.

COURSE OUTCOMES

1. Understand the concept of differentiation and apply for solving differential equations.
2. Remember the concept of definite integral and apply for evaluating surface areas and volumes.
3. Understand the concept of convergence of sequence and series. Also evaluate Fourier series
4. Illustrate the working methods of complex functions and apply for finding analytic functions.
5. Apply the complex functions for finding Taylor's series, Laurent's series and evaluation of definite integrals.

Text Books:-

1. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill Publishing Company Ltd., 2008.
2. B. S. Grewal, Higher Engineering Mathematics, Khanna Publisher, 2005.
3. R. K. Jain & S. R. K. Iyenger , Advance Engineering Mathematics , Narosa Publishing -House, 2002.

Reference Books:-

1. E. Kreyszig, Advance Engineering Mathematics, John Wiley & Sons, 2005.
2. Peter V. O'Neil, Advance Engineering Mathematics, Thomson (Cengage) Learning, 2007.
3. Maurice D. Weir, Joel Hass, Frank R.Giordano, Thomas, Calculus, Eleventh Edition, Pearson.
4. G.B Thomas, R L Finney, Calculus and Analytical Geometry, Ninth Edition Pearson, 2002.
5. James Ward Brown and Ruel V Churchill, Fourier Series and Boundary Value Problems, 8th Edition-Tata McGraw-Hill

6. D. Poole , Linear Algebra : A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
7. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
8. Charles E Roberts Jr, Ordinary Diffrential Equations, Application, Model and Computing, CRC Press T&F Group.
9. Ray Wylie C and Louis C Barret, Advanced Engineering Mathematics, 6th Edition, Tata McGraw-Hill.
10. James Ward Brown and Ruel V Churchill, Complex Variable and Applications, 8th Edition, Tata McGraw-Hill.
11. P. Sivaramakrishna Das and C. Vijayakumari, Engineering Mathematics, 1st Edition, Pearson India Education Services Pvt. Ltd.
12. Advanced Engineering Mathematics By Chandrika Prasad, Reena Garg Khanna Publishing House, Delhi

BASIC ELECTRICAL ENGINEERING

Module - 1: DC Circuits **[08]**

Electrical circuit elements (R, L and C), Concept of active and passive elements, voltage and current sources, concept of linearity and linear network, unilateral and bilateral elements, Kirchhoff‟s laws, Loop and nodal methods of analysis, Star-delta transformation, Superposition theorem, Thevenin theorem, Norton theorem.

Module - 2: Steady- State Analysis of Single Phase AC Circuits **[10]**

Representation of Sinusoidal waveforms – Average and effective values, Form and peak factors, Concept of phasors, phasor representation of sinusoidally varying voltage and current.

Analysis of single phase AC Circuits consisting of R, L, C, RL, RC, RLC combinations (Series and Parallel), Apparent, active & reactive power, Power factor, power factor improvement. Concept of Resonance in series & parallel circuits, bandwidth and quality factor.

Three phase balanced circuits, voltage and current relations in star and delta connections.

Module - 3 : Transformers **[08]**

Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

Module –4 : Electrical machines **[08]**

DC machines: Principle & Construction, Types, EMF equation of generator and torque equation of motor, applications of DC motors (simple numerical problems)

Three Phase Induction Motor: Principle & Construction, Types, Slip-torque characteristics, Applications (Numerical problems related to slip only)

Single Phase Induction motor: Principle of operation and introduction to methods of starting, applications.

Three Phase Synchronous Machines: Principle of operation of alternator and synchronous motor and their applications.

Module –5 : Electrical Installations **[06]**

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Importance of earthing. Types of Batteries, Important characteristics for Batteries.Elementary calculations for energy consumption and savings, battery backup.

COURSE OUTCOMES

1. Apply the concepts of KVL/KCL and network theorems in solving DC circuits.
2. Analyze the steady state behavior of single phase and three phase AC electrical circuits.
3. Identify the application areas of a single phase two winding transformer as well as an auto transformer and calculate their efficiency. Also identify the connections of a three phase transformer.
4. Illustrate the working principles of induction motor, synchronous machine as well as DC machine and employ them in different area of applications.
5. Describe the components of low voltage electrical installations and perform elementary calculations for energy consumption.

Spoken Tutorial (MOOCs):

1. AC DC Circuit Analysis using NgSpice, Open Source Software (http://spokentutorial.org)

Text Books:

1. Ritu Sahdev, "Basic Electrical Engineering", Khanna Publishing House.
2. S. Singh, P.V. Prasad, "Electrical Engineering: Concepts and Applications" Cengage.
3. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill.
4. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill.

Reference Books:

1. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
2. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press.
3. V. D. Toro, "Electrical Engineering Fundamentals", Pearson India.

ELECTRICAL ENGINEERING LABORATORY

LIST OF EXPERIMENTS

Note: A minimum of ten experiments from the following should be performed.

1. Verification of Kirchhoff's laws
2. Verification of Superposition and Thevenin Theorem.
3. Measurement of power and power factor in a single phase ac series inductive circuit and study improvement of power factor using capacitor
4. Study of phenomenon of resonance in RLC series circuit and obtain resonant frequency.
5. Connection and measurement of power consumption of a fluorescent lamp (tube light).
6. Measurement of power in 3- phase circuit by two wattmeter method and determination of its power factor for star as well as delta connected load.
7. Determination of parameters of ac single phase series RLC circuit
8. To observe the B-H loop of a ferromagnetic material in CRO.

9. Determination of (i) Voltage ratio (ii) polarity and (iii) efficiency by load test of a single phase transformer
10. Determination of efficiency of a dc shunt motor by load test
11. To study running and speed reversal of a three phase induction motor and record speed in both directions.
12. Demonstration of cut-out sections of machines: dc machine, three phase induction machine, singlephase induction machine and synchronous machine.

COURSE OUTCOMES

1. Conduct experiments illustrating the application of KVL/KCL and network theorems to DC electrical circuits.
2. Demonstrate the behavior of AC circuits connected to single phase AC supply and measure power in single phase as well as three phase electrical circuits.
3. Perform experiment illustrating BH curve of magnetic materials.
4. Calculate efficiency of a single phase transformer and DC machine.
5. Perform experiments on speed measurement and reversal of direction of three phase induction motor and Identify the type of DC and AC machines based on their construction.

Programming for Problem Solving

Module – 1 : **(Introduction to Programming)** **[08]**

Introduction to components of a computer system: Memory, processor, I/O Devices, storage, operating system, Concept of assembler, compiler, interpreter, loader and linker.

Idea of Algorithm: Representation of Algorithm, Flowchart, Pseudo code with examples, From algorithms to programs, source code.

Programming Basics: Structure of C program, writing and executing the first C program, Syntax and logical errors in compilation, object and executable code. Components of C language.

Standard I/O in C, Fundamental data types, Variables and memory locations, Storage classes.

Module – 2 : **(Arithmetic expressions & Conditional Branching)** **[08]**

Arithmetic expressions and precedence: Operators and expression using numeric and relational operators, mixed operands, type conversion, logical operators, bit operations, assignment operator, operator precedence and associativity.

Conditional Branching: Applying if and switch statements, nesting if and else, use of break and default with switch.

Module – 3 : **(Loops & Functions)** **[08]**

Iteration and loops: use of while, do while and for loops, multiple loop variables, use of break and continue statements.

Functions: Introduction, types of functions, functions with array, passing parameters to functions, call by value, call by reference, recursive functions.

Module – 4 : **(Arrays & Basic Algorithms)** **[08]**

Arrays: Array notation and representation, manipulating array elements, using multi-dimensional arrays. Character arrays and strings, Structure, union, enumerated data types, Array of structures, passing arrays to functions.

Basic Algorithms: Searching &Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, Notion of order of complexity.

Module – 5 :**(Pointer& File Handling)** **[08]**

Pointers: Introduction, declaration, applications, Introduction to dynamic memory allocation (malloc, calloc, realloc, free), Use of pointers in self-referential structures, notion of linked list (no implementation)

File handling: File I/O functions, Standard C preprocessors, defining and calling macros, command-line arguments.

COURSE OUTCOMES

1. To develop simple algorithms for arithmetic and logical problems.
2. To translate the algorithms to programs & execution (in C language).
3. To implement conditional branching, iteration and recursion.
4. To decompose a problem into functions and synthesize a complete program using divide and conquer approach.

5. To use arrays, pointers and structures to develop algorithms and programs.

Text books:

1. Schum‟s Outline of Programming with C by Byron Gottfried, McGraw-Hill
2. The C programming by Kernighan Brain W. and Ritchie Dennis M., Pearson Education. 3. Computer Basics and C Programming by V.Rajaraman , PHI Learning Pvt. Limited, 2015.
4. Computer Concepts and Programming in C, R.S. Salaria, Khanna Publishing House
5. Computer Concepts and Programming in C, E Balaguruswami, McGraw Hill
6. Computer Science- A Structured Programming Approach Using C, by Behrouz A. Forouzan, Richard F. Gilberg, Thomson, Third Edition , Cengage Learning - 2007.
7. Let Us C By Yashwant P. Kanetkar.
8. Problem Solving and Program Design in C, by Jeri R. Hanly, Elliot B. Koffman, Pearson Addison-Wesley, 2006.
9. Programming in C by Kochan Stephen G. Pearson Education – 2015.
10. Computer Concepts and Programming in C by D.S. Yadav and Rajeev Khanna, New AgeInternational Publication.
11. Computer Concepts and Programming by Anami, Angadi and Manvi, PHI Publication.
12. Computer Concepts and Programming in C by Vikas Gupta, Wiley India Publication
13. Computer Fundamentals and Programming in C. Reema Thareja, Oxford Publication
14. Problem Solving and Programming in C, R.S. Salaria, Khanna Publishing House

Programming for Problem Solving Lab

Other Reference: -

1. Use C Open Source Software referring Spoken Tutorial MOOC
1. WAP that accepts the marks of 5 subjects and finds the sum and percentage marks obtained by the student.
2. WAP that calculates the Simple Interest and Compound Interest. The Principal, Amount, Rate of Interest and Time are entered through the keyboard.
3. WAP to calculate the area and circumference of a circle.
4. WAP that accepts the temperature in Centigrade and converts into Fahrenheit using the formula C/5=(F-32)/9.
5. WAP that swaps values of two variables using a third variable.
6. WAP that checks whether the two numbers entered by the user are equal or not.
7. WAP to find the greatest of three numbers.
8. WAP that finds whether a given number is even or odd.
9. WAP that tells whether a given year is a leap year or not.
10. WAP that accepts marks of five subjects and finds percentage and prints grades according to the following criteria:

Between 90-100%----------Print „A"

80-90%----------Print „B"

60-80%----------Print „C"

Below 60%----------Print „D"

11. WAP that takes two operands and one operator from the user and perform the operation and prints the result by using Switch statement.
12. WAP to print the sum of all numbers up to a given number.
13. WAP to find the factorial of a given number.
14. WAP to print sum of even and odd numbers from 1 to N numbers.
15. WAP to print the Fibonacci series.
16. WAP to check whether the entered number is prime or not.
17. WAP to find the sum of digits of the entered number.

18. WAP to find the reverse of a number.
19. WAP to print Armstrong numbers from 1 to 100.
20. WAP to convert binary number into decimal number and vice versa.
21. WAP that simply takes elements of the array from the user and finds the sum of these elements.
22. WAP that inputs two arrays and saves sum of corresponding elements of these arrays in a third array and prints them.
23. WAP to find the minimum and maximum element of the array.
24. WAP to search an element in a array using Linear Search.
25. WAP to sort the elements of the array in ascending order using Bubble Sort technique.
26. WAP to add and multiply two matrices of order nxn.
27. WAP that finds the sum of diagonal elements of a mxn matrix.
28. WAP to implement strlen (), strcat (),strcpy () using the concept of Functions.
29. Define a structure data type TRAIN_INFO. The type contain Train No.: integer type Train name:

string Departure Time: aggregate type TIME Arrival Time: aggregate type TIME Start station: string End station: string The structure type Time contains two integer members: hour and minute. Maintain a train timetable and implement the following operations:

(i) List all the trains (sorted according to train number) that depart from a particular section.

(ii) List all the trains that depart from a particular station at a particular time.

(iii) List all he trains that depart from a particular station within the next one hour of a given time.

(iv) List all the trains between a pair of start station and end station.

30. WAP to swap two elements using the concept of pointers.
31. WAP to compare the contents of two files and determine whether they are same or not.
32. WAP to check whether a given word exists in a file or not. If yes then find the number of times it occurs.

COURSE OUTCOMES

1. To write programs for arithmetic and logical problems.
2. To translate the algorithms to programs & execution (in C language).
3. To write programs for conditional branching, iteration and recursion.
4. To write programs using functions and synthesize a complete program using divide and conquer approach.
5. write programs using arrays, pointers and structures.

ENGINEERING GRAPHICS AND DESIGN

Module 1: Introduction to Engineering Drawing, Orthographic Projections [08]

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Scales – Plain and Diagonal Scales

Principles of Orthographic Projections – Conventions – Projections of Points and Lines inclined to both planes; Projections of planes inclined Planes – Auxiliary Planes.

Module 2: Projections and Sections of Regular Solids [08]

Sections in lined to both the Planes – Auxiliary Views; Simple annotation, dimensioning and scale. Floor plans the include: windows, doors and fixtures such as WC, Both, sink, shower, etc.

Prism, Cylinder, Pyramid, Cone – Auxiliary Vies: Development of surfaces of Right Regular Solids – Prism, Pyramid, Cylinder and Cone.

Module 3: Isometric Projections [08]

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Viceversa, Conversions.

Module 4: Computer Graphics [08]

Listing the computer technologies the impact on graphical communication, Demonstration knowledge of the theory of CAD software [such as: The Menu System, Tollbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects: Isometric Views of lines, Planes, Simple and compound Solids];

Set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles:

Applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through

modifying existing lines (extend/lengthen); Printing documents to pater using the print command: orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modelling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and twodimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, Multi view, auxiliary, and section views. Spatial visualization exercises Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling:

Module 5: Demonstration of a simple team design project [08]

Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid-modelling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).

COURSE OUTCOMES

1: Understanding of the visual aspects of engineering design
2: Understanding of engineering graphics standards and solid modelling
3: Effective communication through graphics
4: Applying modern engineering tools necessary for engineering practice
5: Appling computer-aided geometric design
6: Analysis of Isometric views
7: Creating working drawings

Suggested Text/ Reference Books:

(i) Bhatt N.D., Panchal V.M. & Ingle P.R. (2014), Engineering Drawing, Charotar Publishing House.

(ii) Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education

(iii) Agrawal B. & Agrawal C.M. (2012), Engineering Graphics, TMH Publication

(iv) Engineering Graphics & Design, A.P. Gautam & Pradeep Jain Khanna Publishing House (v) Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.
(Corresponding set of) CAD Software Theory and User Manuals.

WORKSHOP PRACTICE

LIST OF EXPERIMENTS

Machine shop:

- Study of machine tools in particular Lathe machine
- Demonstration of different operations on Lathe machine
- Practice of Facing, Plane Turning, step turning, taper turning, knurling and parting.
- Study of Quick return mechanism of Shaper.

Fitting shop:

- Preparation of T-Shape Work piece as per the given specifications.
- Preparation of U-Shape Work piece which contains: Filing, Sawing, Drilling, Grinding.
- Practice marking operations.

Carpentry:

- Study of Carpentry Tools, Equipment and different joints.
- Practice of Cross Half lap joint, Half lap Dovetail joint and Mortise Tenon Joint

Electrical & Electronics

- Introduction to House wiring, different types of cables. Types of power supply, types of motors, Starters, distribution of power supply, types of bulbs, parts of tube light, Electrical wiring symbols.
- Soldering and desoldering of Resistor in PCB.
- Soldering and desoldering of IC in PCB.
- Soldering and desoldering of Capacitor in PCB

Welding:

- Instruction of BI standards and reading of welding drawings.
- Butt Joint
- Lap Joint
- TIG Welding

- MIG Welding

Casting:

- introduction to casting processes

Smithy

- Sharpening any arc and edge.
- Preparing small arc and edge,
- Repair of agricultural implements and power plough, use of power hammer etc.

Plastic Moulding& Glass Cutting

Introduction to Patterns, pattern allowances, ingredients of moulding sand and melting furnaces.

Foundry tools and their purposes

Demo of mould preparation

Practice – Preparation of mould

Glass cutting

COURSE OUTCOMES

1. Study and practice on machine tools and their operations
2. Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding
3. Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping
4. Welding and soldering operations
5. Apply basic electrical engineering knowledge for house wiring practice

Text Books:

1. Raghuwanshi B.S., Workshop Technology Vol. I & II, Dhanpath Rai & Sons.
2. Kannaiah P. and Narayana K.L., Workshop Manual, 2nd Edn, Scitech publishers.
3. John K.C., Mechanical Workshop Practice. 2nd Edn. PHI 2010.
4. JeyapoovanT.and Pranitha S., Engineering Practices Lab Manual, 3rd Edn. Vikas Pub.2008.

PROFESSIONAL ENGLISH

Module 1- Basics of Technical English **[08]**

Technical English: Definition; Extent& Coverage; Dimensions; Reading; Skimming; Scanning; Churning & Assimilation; Writing: Methods: Inductive; Deductive; Exposition; Linear; Interrupted; Spatial & Chronological etc; Technical Communication; Approaches: Brevity; Objectivity; Simplicity; Utility & Clarity. **Listening**: Active; Passive; Thinking strategies: Positive & Logical thinking; Speaking: Essentials Nuances & Modes of Speech Delivery.

Module 2- Components of Technical Writing **[08]**

Vocabulary Building: Select words; Concept of word formation; Word formation; Root words from foreign languages & their use in English; Prefixes & Suffixes: Derivatives; Synonyms; Antonyms; Abbreviations. Homophones. One word substitutes; Requisites of Sentences.

Module 3- Basic Technical Writing Skills **[08]**

Forms: Business writing: Principle; Purchase & Sales Letters; Drafts; Official Writing: Official Letter; D.O. Letter; Notices; Agenda; Minutes of Meeting; Sentence Structure; Phrases & Clauses in sentences; Coherence; Unity; Emphasis in Writing; Devices; Use of Writing methods in Documents; Techniques of writing.

Module 4- Common Grammatical Errors & Technical Style **[08]**

Subject-verb agreement; Correct usage: Noun; Pronoun; Agreement; Modifiers; Articles; Prepositions; Cliches; Redundancies; Technical Style: Features; Choice of words; Sentences: Descriptive; Narrative; Expository; Defining & Classifying; Length of paragraph; Writing of Introduction & Conclusion.

Module 5- Presentation Strategies & Oral Communications **[08]**Analysis of locale; Audience; Modulating Style & Content; Speaking with confidence; Kinesics;

Paralinguistic features of Voice-Dynamics: Pitch; Intonation; Stress & Rhythm; Conversation & dialogues; Communication at work-place; etc.

COURSE OUTCOMES

1. Students will be enabled to **understand** the basic objective of the course by being acquainted with specific dimensions of communication skills i.e. Reading, Writing, Listening, Thinking and Speaking.
2. Students would be able to **create** substantial base by the formation of strong professional vocabulary for its application at different platforms and through numerous modes as Comprehension, reading, writing and speaking etc.
3. Students will **apply** it at their work place for writing purposes such as Presentation/official drafting/administrative communication and use it for document/project/report/research paper writing.

4. Students will be made to **evaluate** the correct & error-free writing by being wellversed in rules of English grammar & cultivate relevant technical style of communication & presentation at their work place & also for academic uses.

5. Students will **apply** it for practical and oral presentation purposes by being honed up in presentation skills and voice-dynamics. They will apply techniques for developing interpersonal communication skills and positive attitude leading to their professional competence.

Text Books:

1. Technical Communication – Principles and Practices by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, NewDelhi.

Reference Books:

1. Word Power Made Easy by Norman Lewis, W.R.Goyal Pub. & Distributors, 2009, Delhi.
2. Manual of Practical Communication by L.U.B. Pandey; A.I.T.B.S. Publications India Ltd.; Krishan Nagar, 2013, Delhi.
3. English Grammar and Usage by R.P.Sinha, Oxford University Press, 2005, New Delhi.
4. English Grammar, Composition and Usage by N.K.Agrawal&F.T.Wood, Macmillan India Ltd., New Delhi.
5. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House
6. English Grammar & Composition by Wren & Martin, S.Chand& Co. Ltd., New Delhi.
7. Communication Skills for Engineers and Scientists, Sangeeta Sharma et.al. PHI Learning Pvt. Ltd, 2011, New Delhi.
8. Personality Development, Harold R. Wallace &L.Ann Masters, Cengage Learning, New Delhi
9. 9. Personality Development & Soft Skills, BarunK.Mitra, Oxford University Press, 2012 New Delhi.
10. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
11. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.
12. Spoken English- A manual of Speech and Phonetics by R.K.Bansal&J.B.Harrison, Orient Blackswan, 2013, New Delhi.
13. Business English by Ken Taylor, Orient Blackswan, 2011, New Delhi.

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY
LUCKNOW

Evaluation Scheme & Syllabus

For

B.Tech. 2nd Year

(Chemical Engineering)

On

AICTE MODEL CURRICULUM

(Effective from the Session: 2019-20)

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY LUCKNOW

B.TECH (CHEMICAL ENGINEERING)

SEMESTER- III

Sl. No.	Subject Codes	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1	KOE031-38/ KAS302	Engineering Science Course/Maths IV	3	1	0	30	20	50		100		150	4
2	KAS301/ KVE 301	Technical Communication/Universal Human values	2	1	0	30	20	50		100		150	3
			3	0	0								
3	KCH301	Material and Energy Balance	3	1	0	30	20	50		100		150	4
4	KCH302	Chemical Engineering Fluid Mechanics	3	1	0	30	20	50		100		150	4
5	KCH303	Heat Transfer Operations	3	0	0	30	20	50		100		150	3
6	KCH351	Chemical Engineering Fluid Mechanics Lab	0	0	2				25		25	50	1

7	KCH352	Heat Transfer Operations Lab	0	0	2				25		25	50	1
8	KCH353	Soft Computing Lab	0	0	2				25		25	50	1
9	KCS354	Mini Project or Internship Assessment*	0	0	2			50				50	1
10	KNC301/ KNC302	Computer System Security/Python Programming	2	0	0	15	10	25		50			0
11		MOOCs (Essential for Hons. Degree)											
		Total										950	22
*The Mini Project or internship (3-4 weeks) conducted during summer break after II semester and will be assessed during III semester.													

SEMESTER- IV

Sl. No.	Subject Codes	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1	KAS402/ KOE041-48	Maths IV/Engineering Science Course	3	1	0	30	20	50		100		150	4
2	KVE401/ KAS401	Universal Human Values/ Technical Communication	3 2	0 1	0 0	30	20	50		100		150	3
3	KCH401	Mechanical Operations	3	0	0	30	20	50		100		150	3
4	KCH402	Chemical Reaction Engineering-I	3	1	0	30	20	50		100		150	4
5	KCH403	Chemical Engineering Thermodynamics	3	1	0	30	20	50		100		150	4
6	KCH451	Mechanical Operations Lab	0	0	2				25		25	50	1

7	KCH452	Chemical Reaction Engineering Lab	0	0	2				25		25	50	1
8	KCH453	Numerical Methods of Analysis Lab	0	0	2				25		25	50	1
9	KNC402/ KNC401	Python Programming/Computer System Security	2	0	0	15	10	25		50			0
10		MOOCs (Essential for Hons. Degree)											
		Total										900	21

SEMESTER-III

SUBJECT CODE:KCH 301 **COURSE TITLE: Material And Energy Balance**

EXAMINATION DURATION: 3 Hrs. **SEMESTER: III (ODD)**

L:3 T:1 P:0 C:4 **PRE-REQUISITE: NIL**

OBJECTIVE: To provide basic knowledge of principles of material and energy balances applied to chemical engineering systems.

COURSE OUTCOME:

After successful completion of the course the students will be able to:

1. Apply steady-state and unsteady state material and energy balance on a system.
2. Analyze all the stiochiometric and balances being applied on a system undergoing chemical process.

3. Design equipment with inlet and outlet; including recycle- bypass streams for a chemical process.

REFERENCE BOOKS:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Himmelblau D.M. and Riggs J. B.," Principles and Calculationsth in Chemical Engineering", 8 Ed., Prentice Hall of India.	2012
2.	Felder R.M. and Rousseau R.W., "Elementary Principles of rd Chemical Processes", 3 Ed.., John Wiley.	2005
3.	th Bhatt B.I. and Vora S.M., "Stoichiometry", 5 Ed., Tata McGraw-Hill	2010
4.	Narayanan K.V. and Lakshmikutty B., "Stoichiometry and Process Calculations", Prentice Hall of India.	2006
5.	Hougen D.A., Watson K.M. and Ragatz R.A., "Chemical nd Process Principles", Part-I, 2 Ed., CBS Publishers.	1995

COURSE DETAILS:

Units	S. No.	Contents	Lecture Hours

I	1.	Introduction: Units and dimension in chemical engineering, units conversion of dimensional equations, stoichiometric and composition relations, concept of degrees of freedom and linear independence of a set of equations.	5
	2.	Material Balance: Concept of material balance, open and closed systems, steady state and unsteady state, multiple component system, selection of a basis, problem solving strategy.	4
II	3.	Material Balance without Chemical Reaction for Single and Multiple Units: Conservation of mass/atom, material balance for Systems without chemical reactions involving single unit and multiple units.	5
	4.	Material Balance with Chemical Reaction for Single and Multiple Units: Concept of excess reactant, extent of reaction, Material balance for systems with chemical reactions involving single unit and multiple units.	6
III	5.	Recycle, Bypass, Purge and Industrial Applications: Calculations for a cyclic processes involving recycle/ purge/ bypass, material balances involving gases, vapors, liquids and solids and use of real gas relationships, material balance involving gases, vapors, liquids & solids and uses of real gas relationships, vapor-liquid equilibrium and concepts of humidity & saturation, analysis of systems with bypass, recycle and purge, analysis of processes involving condensation, crystallization and vaporization.	7
IV	6.	Energy Balance: Conservation of energy with reference to general energy balance with and without chemical reactions, chemical engineering problems involving reversible processes and mechanical energy balance.	4
	7.	Applications of Energy Balance: Calculations of heat of change of phase (solid – liquid & liqid – vapor), heat of reaction, heat of combustion, heat of solutions and mixing, determination of temperatures for adiabatic and nonadiabatic reactions, use of psychometric and enthalpy-concentration diagrams.	6

V	8.	Simultaneous Material and Energy Balances: Degrees of freedom analysis for multicomponent systems, combined steady state material and energy balances for units with multiple sub-systems.	3
	9.	Unsteady State Material and Energy Balances: Transient materials and energy balances involving with and without chemical reactions.	2
		TOTAL	42

SUBJECT CODE:KCH 302 **COURSE TITLE: Chemical Engg. Fluid Mechanics**

EXAMINATION DURATION: 3 Hrs. **SEMESTER: III (ODD)**

L:3 T:1 P:0 C:4 **PRE-REQUISITE: NIL**

OBJECTIVE: To present the fundamental insights of fluids and their static and dynamic behaviors and fluid machineries, etc.

COURSE OUTCOME:

On completion of this course, the students will be able to

1. Understand the properties and flow of fluid.
2. Analyse the model and prototype.
3. Explain the factors influencing velocity profiles for laminar and turbulent flow.
4. Design the pumps and compressors for optimum operation.

REFERENCE BOOKS:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint

1.	Nevers N.D., "Fluid Mechanics For Chemical Engineers", 3rd Ed., McGraw Hill Higher Education.	2005
2.	Cengel Y.A. and Cimbala J.M. "Fluid Mechanics: Fundamentals and Applications", 2nd Ed. McGraw-Hill	2010
3.	Balachandran P. "Engineering Fluid Mechanics", PHI Learning Pvt Ltd., New Delhi	2012
4.	Munson B.R., Young D.F., Okiishi T.H. and Huebsch W.W., "Fundamentals of Fluid Mechanics", 6th Ed., Willey	2010
5.	White F.M. "Fluid Mechanics", 7th Ed. Tata McGraw-Hill	2010
6.	Rajput, R. K., "Textbook of Fluid Mechanics", S. Chand and Co., New Delhi.	1998

COURSE DETAILS:

Units	S. No.	Contents	Lecture Hours
I	1.	Introduction: Fundamental concepts of fluids; Fluid statics, kinematics and dynamics; Properties of fluids.	3
	2.	Fluid Statics: The basic equation of fluid statics; Pressure – depth relationship; Pressure forces on plane and curved surfaces; Buoyancy and stability; Forces on immersed and submerged bodies; Pressure measurements; Pressure in accelerated rigid body motions.	6
II	3.	Elementary Fluid Kinematics: Lagrangian and Eulerian descriptions; Flow visualization – streamline, pathline, streakline and timeline, profile plots; Description and classification of fluid motions; Rotational, irrotational, inviscid and potential flows; Deformation of fluids; System and control volume representation; Reynolds transport theorem.	6
III	4.	Dynamic Analysis of Flow: Conservation of mass, linear and angular momentum, and energy; Eulers equation of motion, Bernoulli theorem; Navier-Stokes equations.	6

	5.	Dimensional Analysis, Similitude and Modeling: Dimensional homogeneity and analysis; Methods of finding dimensionless numbers; Selection of variables, Rayleigh and Buckingham's π method; Common dimensionless numbers and their physical significance; Model and Prototypes; Complete and incomplete similarity.	3
IV	6.	Internal Incompressible Viscous Flow: General characteristics of pipe flow – laminar, turbulent, entrance region, fully developed; Fully developed laminar/turbulent flow in pipe – shear stress distribution and velocity profiles; Energy correction factors; Energy and hydraulic grade lines; Major and minor losses in pipes, fittings, pipe network; Friction factor.	7
	7.	Flow Measurements: Flow rate and velocity measurements – Pitot tube, orifice meter, venturimeter, rotameter, notches and weirs.	2
V	8.	Fluid Handling Machinery: Classification; Positivedisplacement pumps and compressors, centrifugal pumps and compressors, Axial flow pumps and compressors, compressor efficiency. Characteristics of centrifugal pumps; NPSH; Selection of pumps.	6
	9.	Agitation and Mixing: Agitated vessels; Blending and mixing; Suspension of solid particles; Dispersion operations; Agitator selection and scale up.	3
		TOTAL	42

SUBJECT CODE:KCH 303 **COURSE TITLE:Heat Transfer Operations**

EXAMINATION DURATION: 3 Hrs. **SEMESTER: III (ODD)**

L:3 T:0 P:0 C:3 **PRE-REQUISITE: NIL**

OBJECTIVE: To provide basic knowledge about heat transfer and its processes used in Chemical Process Industries.

COURSE OUTCOME:

On completion of this course, the students will be able to

1. apply basic principles of heat transfer for designing heat transfer systems.
2. model heat transport systems and develop predictive correlation.
3. assess and evaluate various designs for heat transfers and optimize the solution

REFERENCE BOOKS:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Holman, J. P., Heat Transfer, 10th Edition., Tata McGraw-Hill Education Private ltd.	2011
2.	Kern, D.Q., Process Heat Transfer, 1st Edition, Tata McGrawHill Education Private ltd.	2001
3.	Cengel Y.A. and Ghajar A.J., "Heat and Mass Transfer: Fundamentals and Applications", 4th Ed., McGraw Hill	2010
4.	McCabe, W.L, Smith J.C, and Harriot, P, Unit Operations in Chemical Engineering, 7th Edition, McGraw-Hill, Inc.	2004
5.	Coulson, J.M. and Richardson, J.F, Chemical Engineering, Vol. I, 6th Edition, Elsevier India.	1999

COURSE DETAILS:

Units	S. No.	Contents	Lecture Hours
I	1.	Introduction: Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer.	2

	2.	Conduction: Fourier's law of heat conduction; One dimensional steady state heat conduction equation for flat plate; Hollow cylinder - Heat conduction through a series of resistances; Thermal conductivity measurement; Effect of temperature on thermal conductivity; Heat transfer in extended surfaces; Numerical Methods for solving conduction heat transfer problem (Explicit and Implicit methods); Stability criteria.	6
II	3.	Convection Concepts of heat transfer by convection; Natural and forced convection; Analogies between transfer of momentum and heat; Reynold's analogy; Prandtl and Coulburn analogy. Dimensional analysis; Correlations for the calculation of heat transfer coefficients; Heat transfer coefficient for flow through a pipe; Flow through non circular conduit; Flow past flat plate; Extended surface. Lumped system analysis; Heat transfer augmentations.	6
III	4.	Radiation: Heat transfer by radiation; Emissive power; Black body radiation; Emissivity, Kirchoff's law; Stefan - Boltzman law; Plank's law; Radiation between surfaces.	7
	5.	Evaporator: Classification and use of evaporators in process industries, effect of boiling point rise on evaporator performance, Single effect and multiple effect evaporation - Design calculation for single and multiple effect evaporation.	4
IV	6.	Boiling: Characteristics, nucleate pool- and forced convection-boiling, boiling mechanism and curve, heat transfer correlations, heat pipes.	4
	7.	Condensation: Mechanism and types of condensation of vapor; Drop wise and film wise condensation; Nusselt equation for vertical and horizontal tubes; Condensation of superheated vapours; Effect of non-condensable gasses on rate of condensation.	5

	8.	Heat Exchangers: Parallel and counter flow heat exchangers; Log mean temperature difference; Single passand multi pass heat exchangers; Double pipe; Shell and tube; Plate and frame heat exchangers; use of correction factor charts; Heatexchangers effectiveness; Number of transfer unit; Chart for different configurations;Fouling factors; Design of heat exchangers; Selection criteria and application of Heat exchanger; Introduction to TEMA type heat transfer and applications	8
		TOTAL	42

SUBJECT CODE:KCH 351 **COURSE TITLE:Chemical Engg. Fluid Mechanics Lab**

EXAMINATION DURATION: 3 Hrs. **SEMESTER: III (ODD)**

L:0 T:0 P:2 C:1

OBJECTIVE: To determine the various parameters related to fluid flow in pipes and in open channels.

LAB OUTCOME:

On completion of the experiments, the students will be able to

1. Calculate coefficient of discharge through v-notch, venturimeter, and orificemeter..
2. Determine friction losses through different pipes and fittings.
3. Calculate the efficiency of centrifugal pump.
4. Study different types of flow and analyse Bernoulli's law.

LIST OF EXPERIMENTS:

1. To find the flow rate using a V notch
2. To find the friction losses in a Straight pipe and in a Bend pipe.
3. Study of Pipe fittings and Valves
4. To study the working principle of a centrifugal pump and determine its efficiency experimentally.
5. Determination of coefficient of velocity, coefficient of resistance, coefficient ofcontraction.
6. To determine the pressure drop in a packed bed.
7. Determination of discharge coefficient with Reynolds Number in case of an orifice meter and a venturi meter.
8. Study and verification of the flow pattern in a Bernoulli's apparatus
9. To determine the minimum fluidization velocity in a fluidized bed.
10. Determination of the fluidization index, segregation index in a fluidized bed
11. Determine the Reynolds number and study different types of flow.

COURSE TITLE: Heat Transfer Operation Lab

SUBJECT CODE:KCH 352

EXAMINATION DURATION: 3 Hrs. **SEMESTER: III (ODD)**

L:0 T:0 P:2 C:1 **PRE-REQUISITE: NIL**

OBJECTIVE: To determinethe amount of heat exchange in various modes of heat transfer includingcondensation & boiling for several geometries.

LAB OUTCOME:

On completion of this course, the students will be able to

1. Determine the thermal conductivity of different materials.
2. Calculate the rate of heat transfer through different types of heat ex-changers in different flow patterns.
3. Study the natural convection phenomena and temperature distribution in various setups(like composite wall, lagged pipe etc.).

LIST OF EXPERIMENTS:

1. To find out the thermal conductivity of liquids.
2. To find out the thermal conductivity of a metal rod.
3. Find out the Heat Transfer Coefficient during drop wise and film wise condensation.
4. Find out the Heat Transfer Coefficient in a vertical and a horizontal condenser.
5. To find out the emissivity of a surface.
6. To find out the overall thermal conductance and plot the temperature distribution in case of a composite wall.
7. To find out the average heat transfer co-efficient of vertical cylinder in natural convection.
8. To find out the Stefan Boltzman's constant and compare with the theoretical value.
9. To find out the relation between insulation thickness and heat loss.
10. To find out the overall heat transfer co-efficient of a double pipe heat exchanger.
11. To find out the overall heat transfer co-efficient of 1-2 shell & tube heat exchanger.
12. Study and operation of a long tube evaporator.

SUBJECT CODE:KCH 353 **COURSE TITLE:Soft Computing Lab**

EXAMINATION DURATION: 3 Hrs. **SEMESTER: III (ODD)**

L:0 T:0 P:2 C:1 **PRE-REQUISITE: NIL**

OBJECTIVE: To use different softwares for solving basic problems of engineering.

LAB OUTCOME:

On completion of this course, the students will be able to

1. Understand the importance of software.
2. Solve basic chemical engineering problems using MS-EXCEL and MATLAB.

LIST OF EXPERIMENTS:

Experiment using MS-EXCEL and MATLAB.

1. To apply material balance on any chemical engineering unit operation.

2. To apply energy balance on any chemical engineering unit operation.
3. To work on heat transfer problems.
4. To work on a exchanger or evaporator designing using kern's method.
5. To find out effect on conversion and time of operation in a batch reactor.
6. To design a distillation column, feed height and number of trays in a column using Mccabe thiele method.

SUBJECT CODE:KCH 354 **COURSE TITLE:Mini Project/ Seminar**

EXAMINATION DURATION: 3 Hrs. **SEMESTER: III (ODD)**

L:0 T:0 P:2 C:1 **PRE-REQUISITE: NIL**

OBJECTIVE: To develop presentation skills and enhance knowledge on various fields in chemical engineering through technical seminars.

COURSE DETAILS:

Students will undergo a mini project in departmental laboratories under the guidance of a teacher and present the same at the end of semester OR They will study some technical topic and present the same.

SEMESTER-IV

SUBJECT CODE:KCH 401 **COURSE TITLE: Mechanical Operations**

EXAMINATION DURATION: 3 Hrs. **SEMESTER: IV (EVEN)**

L:3 T:0 P:0 C:3 **PRE-REQUISITE: NIL**

OBJECTIVE: To impart Knowledge on particle size analysis, size reduction, separation of solid particles from fluids and flow through porous media.

COURSE OUTCOME:

On completion of this course, the students will be able to

1. Measure the particle size,
2. Estimate the crushing efficiency of different type's crushers.
3. Explain the particle sedimentation.
4. Design the storage area for the different types of solids.

REFERENCE BOOKS:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Backhurst, J. R. and Harker J. H.,"Coulson and Richardson th Chemical Engineering", Vol. II",5 Ed., ButterworthHeinemann.	2004
2.	McCabe W.L., Smith J.C and Harriott P., "Unit Operations of th Chemical Engineering", 7 Ed. , McGraw Hill.	2005
3.	Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., Principles of Unit Operations, 2nd Edition., John Wiley & Sons	1980

4.	Brown G.G., Unit Operations, CBS Publishers & Distributors	2005
5.	Hiramath R.S., Kulkarni A.P., Unit Operations of Chemical Engineering, 9th Edition, Everest Publications	2004
6.	Narayanan C.M. & Bhattacharya B.C., "Mechanical Operation for Chemical Engineers –Incorporating Computer Aided Analysis", Khanna Publishers.	1992

COURSE DETAILS:

Units	S. No.	Contents	Lecture Hours
I	1.	Particles Size Analysis: General characteristics of solids; Different techniques of size analysis; Shape factor; Surface area determination; Estimation of particle size; Screening methods and equipment; Screen efficiency; Ideal and actual screens.	6
II	2.	Size Reduction: Methods of size reduction; Classification of equipments; Crushers; Grinders; Disintegrators for coarse, Intermediate and fine grinding; Laws of size reduction; Energy relationships in size reduction; power requirement; Work index	6
	3.	Size Enlargement: Principle of granulation; Briquetting; Pelletisation; Flocculation.	3
III	4.	Particle Separation: Gravity settling; Sedimentation; Thickening; Elutriation; Double cone classifier; Rake classifier; Bowl classifier; Centrifugal separation; Continuous centrifuges; Design of basket centrifuges; Industrial dust removing equipment; Cyclones; Hydro cyclones; Electrostatic - Magnetic separators; Heavy media separations; Floatation; Jigging	7
IV	5.	Flow through Porous media (Filtration): Theory of filtration,Batch and continuous filters, Filtration equipments; Rotary drum filter; Plate and frame filter; Leaf filter; Notch filter; Sand filter; Bag filter; Selection; Operation; Filter aids. Flow through filter cake and Filter media; Compressible and incompressible filter cakes; Design of filters and optimum cycle of operation.	7
	6.	Fluidization: Fluidization characteristics, aggregative and particulate fluidization, voidage and minimum fluidization velocity,terminal velocity of particles; entrainment; pressure drop in fluidization.	4
V	7.	Mixing and agitation: Mixing of liquids (with or without solids); Mixing of powders; Ribbon blender; Screw blender; Double cone blender; High viscous mixer; Banbury mixer; Selection of suitable mixers; Power requirement for mixing	5

COURSE DETAILS:

	8.	Storage and conveying of solids: Bunkers; Silos; Bins; Hoppers; Transportation of solids in bulk; Conveyer selection; Types of conveyers; Belt Conveyor; Bucket conveyor; Screw conveyor; Pneumatic conveyor; Their performance and characteristics.	4
		TOTAL	42

COURSE TITLE: Chemical Reaction

SUBJECT CODE:KCH 402

Engineering-I

EXAMINATION DURATION: 3 Hrs. SEMESTER: IV (EVEN)

L:3 T:1 P:0 C:4 PRE-REQUISITE: NIL

OBJECTIVE: To provide the comprehensive knowledge of reaction engineering and chemical reactors.

COURSE OUTCOME:

On completion of this course, the students will be able to

1. Identify the reaction type and their kinetics.
2. Design the reactor for the batch and continuous chemical process.
3. Understand the Ideal and Non – Ideal Reactors.

REFERENCE BOOKS:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Levenspiel O, Chemical Reaction Engineering, 3rd Edition, Wiley India Pvt Ltd.	2010
2.	Smith, J.M, Chemical Engineering Kinetics, 3rd Edition McGraw.	2014

COURSE DETAILS:

3.	Fogler.H.S., Elements of Chemical Reaction Engineering, 4th Edition, Phi Learning Pvt Ltd (RS).	2009
4.	Froment. G.F. & K.B.Bischoff,Chemical Reactor Analysis and Design, 3rd Edition, Wiley.	2010
5.	Butt, J.B., " Reaction Kinetics and Reactor Design" 2nd Ed., CRC Press	2000

Units	S. No.	Contents	Lecture Hours
I	1.	Rate Equations: Rate equation – elementary - non-elementary reactions - theories of reaction rate and temperature dependency - Design equation for constant and variable volume batch reactors - analysis of experimental kinetics data - integral and differential analysis.	8
II	2.	Design of Reactors: Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors - combination of reactors - size comparison of reactors.	9
III	3.	Design of Multiple Reactors: Design of reactors for multiple reactions – consecutive - parallel and mixed reactions – factors affecting choice - optimum yield and conversion - selectivity, reactivity and yield.	9

COURSE DETAILS:

IV	4.	Non – isothermal Reactors: Non-isothermal homogeneous reactor systems - adiabatic reactors - rates of heat exchanges for different reactors - design for constant rate input and constant heat transfer coefficient - operation of batch and continuous reactors - optimum temperature progression.	8
V	5.	Non Ideal Reactors: The residence time distribution as a factor of performance; residence time functions and relationship between them in reactor; basic models for nonideal flow; conversion in non ideal reactors.	8
		TOTAL	42

COURSE TITLE:Chemical Engg.

SUBJECT CODE:KCH 403

Thermodynamics

EXAMINATION DURATION: 3 Hrs. SEMESTER: IV (EVEN)

L:3 T:1 P:0 C:4 PRE-REQUISITE: NIL

OBJECTIVE: To apply the laws of thermodynamics in solving problems related to flow processes and phase equilibrium of heterogeneous and reacting systems

COURSE DETAILS:

COURSE OUTCOME:

On completion of this course, the students will be able to

1. Identify the thermodynamic property of the pure substance and mixture.
2. Know the basic principles of refrigeration and liquefaction process.
3. Understand the relation between thermodynamic and chemical reactions

REFERENCE BOOKS:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Smith, J.M., VanNess, H.C., & Abbot M.C, Introduction to Chemical Engineering Thermodynamics, 7th Edition, Tata Mcgraw Hill Education Private Limited.	2009
2.	Narayanan K.V, Text Book of Chemical Engineering Thermodynamics, Phi Learning Pvt. Ltd-New Delhi.	2013
3.	Hougen, O.A., Watson, K.M., and Ragatz, R.A., Chemical Process Principles Part II", Thermodynamics, John Wiley.	1970
4.	Dodge, B.F., Chemical Engineering Thermodynamics,1st Edition, 6th im edition McGraw-Hill,.	1944
5.	Sandler, S.I., Chemical,Biochemical and Engineering Thermodynamics, 4th Edition, Wiley.	2006

Units	S. No.	Contents	Lecture Hours
I	1.	Thermodynamic Laws and Property Relations: Laws of thermodynamics and their applications; PVT behaviour of pure substances; PVT behaviour of mixtures; Generalized equations of state;Joule's experiment; Carnot cycle and Carnot theorems; Thermodynamic property relations; Maxwell relations; Partial derivatives and Jacobian method; Residual properties; Partial molar properties; Excess properties of mixtures; Thermodynamic property tables and diagrams,	10

COURSE DETAILS:

II	2.	Properties of Solutions and Phase Equilibria: Criteria for equilibrium between phases in multi component non-reacting systems in terms of chemical potential and fugacity; Application of phase rule; Vapour-liquid equilibrium; Phase diagrams for homogeneous systems and for systems with a miscibility gap; Effect of temperature and pressure on azeotrope composition; Liquid-liquid equilibrium; Ternary liquid liquid equilibrium.	8
III	3.	Correlation and Prediction of Phase Equilibria: Activity coefficient; Composition models; thermodynamic consistency of phase equilibria; Application of the correlation and prediction of phase equilibria in systems of engineering interest particularly to distillation and liquid extraction processes.	8
IV	4.	Chemical Reaction Equilibria: Definition of standard state; standard free energy change and reaction equilibrium constant; evaluation of reaction equilibrium constant; prediction of free energy data; equilibria in chemical reactors, calculation of equilibrium compositions for homogeneous chemical reactors; thermodynamic analysis of simultaneous reactions.	8
V	5.	Refrigeration:Principles of refrigeration; methods of producing refrigeration; liquefaction process; coefficient of performance; evaluation of the performance of vapour compression and gas refrigeration cycles.	8
		TOTAL	42

COURSE TITLE:Mechanical Operations Lab **SEMESTER: IV (EVEN)**

PRE-REQUISITE: NIL

OBJECTIVE: Generate familiarity with process equipment and develop engineeringjudgment.

LAB OUTCOME:

On completion of this course, the students will be able to

1. Measure the particle size.
2. Estimate the crushing efficiency of different type's crushers.
3. Calculate medium and filter resistance of filters.
4. Estimate the pressure drop in packed and fluidized bed

LIST OF EXPERIMENTS:

1. Determination of average particle size of a mixture of particles by sieve analysis.
2. Study and operation of Jaw crusher and thereby verification of Ritinger's constant.
3. Determination of reduction ratio, maximum feed size and theoretical capacity of crushing rolls.
4. Study of Ball mill and comparison of its critical speed with the operating speed.
5. Study and operation of a Hammer mill thereby finding its reduction ratio.
6. Study and operation of a cyclone separator and thereby finding its efficiency of separation.
7. Study and operation of a Magnetic separator and thereby finding its efficiency of separation.
8. Study and operation of a Gyratory Crusher and thereby finding its reduction ratio
9. To find the cake and filter medium resistance of Plate and Frame Filter press.
10. To find the filter medium resistance of a Vacuum Leaf Filter.

COURSE TITLE:Chemical Reaction Engg. Lab **SEMESTER: IV (EVEN)**

PRE-REQUISITE: NIL

OBJECTIVE: To provide the comprehensive knowledge of reaction engineering and chemical reactors.

LAB OUTCOME:

On completion of this course, the students will be able to

1. Analyse the reaction type and their kinetics.
2. Design the reactor for the batch and continuous chemical process.

LIST OF EXPERIMENTS:

1. Find out kinetic constant and study conversion of a given reaction in a batch reactor
2. Find out kinetic constant and study conversion of a given reaction in a plug flowreactor
3. Find out kinetic constant and study conversion of a given reaction in a CSTR
4. Study and operation of an adiabatic batch reactor
5. Study of a reversible reaction in a batch reactor
6. To determine energy of activation of reaction of ethyl acetate with sodium hydroxide
7. Find out specific rate contant and activation energy of a reaction in a plug flow reactor
8. To determine reaction equilibrium constant of reaction of acetic acid with ethanol.
9. To determine changes in free energy, enthalpy and entropy for the reaction of potassium iodide with iodine.
10. Study and operation of a cascade CSTR

    The reaction of disappearance of phenolphthalein in NaOH solutions may be used for experiments 1 and 2.

COURSE TITLE:Numerical Methods Of Analysis Lab **SEMESTER: IV (EVEN)**

PRE-REQUISITE: NIL

OBJECTIVE: To teach the student various numerical methods toanalysis the problems of linear, nonlinear and ODE equations, interpolation and approximation, numerical differentiation and integration etc.

LAB OUTCOME:

On completion of this lab, the students will be able to

1. Compare thecomputational methods for advantages and drawback,
2. Implement the computational methods using any ofexisting programming languages, test such methods and compare between them,
3. Identify thesuitable computational technique for a specific type of problems and develop thecomputational method that is suitable for the underlying problem.

LIST OF EXPERIMENTS:

Use of following Techniques in C/C++ Language or Matlab software

1. Solution of single non-linear algebraic equations by Newton Raphson method.
2. Solution of single non-linear equations by Regulafalsi method.
3. Solution of system of linear simultaneous by Gauss Elimination method.
4. Solution of system of linear simultaneous equation by gauss seidel method and successive over relaxation method.
5. Solution of single first order ordinary differential equations by fourth order Runge-Kutta method.
6. Solution of Heat equations (Parabolic equations) by finite difference method.
7. Solution of Laplace equations (elliptic equation) by finite difference method.
8. Solution of wave equations (Hyperbolic equation) by finite difference method.
9. Finding Newton's interpolatory polynomial for n points.
10. Finding Newton's interpolatory polynomial based on finite difference table for n points.
11. Simpson's 3/8-rule.9.

B.I.E.T (An autonomous Institute)
Jhansi U.P

Syllabus

3rd and 4th Year

[Effective from session 2009-10]

B.TECH. CHEMICAL ENGINEERING
Name Of Course: B.Tech.(Chem.Engg.)

B.I.E.T (An autonomous Institute) Jhansi U.P

Study and Evaluation Scheme

[Effective from the Session 2010-11]

B. Tech. (Chem. Engg) Year 3rd, Semester -V

S. No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credits
						Sessional Exam.			ESE		
			L	T	P	CT	TA	Total			
The ory Subjects											
1	EHU501	Engineering and Managerial Economics	3	1	0	30	20	50	100	150	3
2	EAS501	Computer based Numerical Methods	3	1	0	30	20	50	100	150	4
3	ECH501	Mass Transfer Operations-I	3	1	0	30	20	50	100	150	4
4	ECH502	Chemical Reaction Engineering- II	3	1	0	30	20	50	100	150	4
5	ECH503	Chemical Technology - II	3	0	0	15	10	25	50	75	3
6	ECH504	Process Instrumentation	2	0	0	15	10	25	50	75	3
7	EHU111	*Human Values & Professional Ethics	2	2	0	15	10	25	50	75	-
Practical/Design											
8	EAS551	Computer Based Numerical Methods	0	0	3	10	10	20	30	50	1
9	ECH551	Mass Transfer Operations-I Lab	0	0	3	10	10	20	30	50	1
10	ECH552	Process Instrumentation lab	0	0	3	10	10	20	30	50	1
11	ECH553	Group discussion & Seminar	0	0	2	-	-	50	-	50	1
12	GP 501	General Proficiency	-	-	-	-	-	50	-	50	1
			17	4	11	-	-	410	590	1000	26

[Effective from the Session 2010-11]

Year 3rd , Semester VI

S. No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credits
						Sessional Exam.			ESE		
			L	T	P	CT	TA	Total			
Theory Subjects											
1	EHU-601	Industrial Management	3	0	0	30	20	50	100	150	3
2	ECH 011ECH 013	Departmental Elective -I	3	1	0	30	20	50	100	150	4
3	ECH 021ECH 024	Departmental Elective -II	2	1	0	15	10	25	50	75	3
4	ECH-601	Mass Transfer Operations-II	2	1	0	15	10	25	50	75	3
5	ECH-602	Process Dynamics & Control	3	1	0	30	20	50	100	150	4
6	ECH-603	Process Equipment Design	3	1	0	30	20	50	100	150	4
7	EHU-111	*Human Values & Professional Ethics	2	0	0	15	10	25	50	75	-
Practical/Design											
8	ECH-651	Mass Transfer Operations – II Lab	0	0	3	10	10	20	30	50	1
9	ECH-652	Process Dynamics & Control Lab	0	0	3	10	10	20	30	50	1
10	ECH-653	Energy Lab	0	0	2	10	10	20	30	50	1
11	ECH-654	Equipment Design	0	0	2	10	10	20	30	50	1
12	GP-601	General Proficiency	-	-	-	-	-	50	-	50	1
			16	5	10	-	-	410	590	1000	26

Departmental Elective I

ECH-011: Energy Resources & Utilization

ECH-012: Energy Management

ECH-013: Energy Efficiency & Energy Conservation

Departmental Elective-II

ECH-021: Optimization Technique in Chemical Engineering
ECH-022: Computational Fluid Dynamics

ECH-023: Statistical Design of Experiments

ECH-024: Process Flow Sheet Simulation

[Effective from the Session 2011-12]

th
Year 4 , Semester -VII

S. No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credits
						Sessional Exam.			ESE		
			L	T	P	CT	TA	Total			
Theory Subjects											
1	EOE071EOE074	Open Elective- I	3	1	0	30	20	50	100	150	4
2	EOE031EOE034	Departmental Elective -III	3	1	0	30	20	50	100	150	4
3	EOE041EOE044	Departmental Elective -IV	3	1	0	30	20	50	100	150	4
4	ECH 701	Process Modeling & Simulation	3	1	0	30	20	50	100	150	4
5	ECH 702	Plant Design & Economics	3	1	0	30	20	50	100	150	4
6	EHU-111	*Human Values & Professional Ethics	2	0	0	15	10	25	50	75	-
Practical/Design											
7	ECH 751	C A D Lab	0	0	3	10	10	20	30	50	1
8	ECH 752	Project	0	0	3	-	50	50	-	50	2
9	ECH 753	Group discussion & Seminar	0	0	2	-	50	50	-	50	1
10	ECH 754	Industrial Training VivaVoce**	0	0	2	-	50	50	-	50	1
11	GP 701	General Proficiency	-	-	-	-	-	50	-	50	1
			15	5	10	160	260	470	530	1000	26

Note-**Practical Training (4-6weeks) done after 6_{th} Semesters would be evaluated in 7_{th} semester through Report and viva voce etc.

Open Electives-I

EOE 071: Entrepreneurship Development
EOE 072: Quality Management
EOE 073: Operations Research

EOE 074: Introduction to Biotechnology

Departmental Elective –III

ECH 031: Air Pollution and Control Equipments

ECH 032: Industrial Pollution Abatement & Waste Management
ECH 033: Environmental Pollution Monitoring & Control
ECH 034: Hazardous Waste Management

Departmental Elective –IV

ECH 041: Process Utility & Safety in Chemical Plants ECH 042: Corrosion Science & Engineering

ECH 043: Project Engineering & Management ECH 044: Industrial Safety & Hazard Management

[Effective from the Session 2011-12]

th
Year 4 , Semester -VIII

S. No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credits
						Sessional Exam.			ESE		
			L	T	P	CT	TA	Total			
Theory Subjects											
1	EOE 081EOE 084	Open Elective- II	3	1	0	30	20	50	100	150	4
2	ECH 051ECH 054	Departmental Elective -V	3	1	0	30	20	50	100	150	4
3	ECH 061ECH 063	Departmental Elective -VI	3	1	0	30	20	50	100	150	4
4	ECH- 801	Transport Phenomena	3	1	0	30	20	50	100	150	3
5	EHU-111	*Human Values & Professional Ethics	2	0	0	15	10	25	50	75	-
Pra ctical/Design											
6	ECH-851	Project **	0	0	12	-	100	100	250	350	8
7	GP 801	General Proficiency	-	-	-	-	-	50	-	50	1
			15	5	10	160	260	470	530	1000	24

Note. ** Project should be initiated in 7_{th} semester beginning, and should be completed by the end of 8_{th} semester with good Report and power-point Presentation etc

Open Elective- II

EOE 081: Non Conventional Energy Resources
EOE 082: Nonlinear Dynamic Systems
EOE 083: Product Development
EOE 084: Automation and Robotics

Departmental Elective –V

ECH 051: Advance Separation Technology
ECH 052: Design of Piping Systems
ECH 053: Fluidization Engineering
ECH 054: Multiphase Reactor Design

Departmental Elective –VI

ECH 061: Fertilizer Technology

ECH 062: Petroleum Refining Technology

ECH 063: Petrochemical Technology

DEPARTMENT OF CHEMICAL ENGINEERING

ECH 501: MASS TRANSFER OPERATIONS – I **3 1 0**

COURSE OUTCOME:
On completion of this course, the students will be able to

1. To analyse the uses and characterization of separation processes.
2. Study of various cascade systems and the energy requirement of separation processes.
3. Classification of various membranes in separation processes which is used for reverse osmosis.
4. To study the concepts of dialysis.
5. To analyse chromatographic separation and molecular sieve separations.

Syllabus

Unit I

Diffusion : Molecular and turbulent diffusion, diffusion coefficient, Fick's Law of diffusion, Dependence of diffusion coefficient on temperature, pressure and composition; measurement and estimation of diffusivity. Diffusion in multi -component gas mixtures. Diffusion in Solids: Molecular, Knudsen & surface diffusion;
Inter- phase mass transfer: Mass transfer coefficients, Diffusion between phases, Equilibrium solubility of gases in liquids, Mass transfer theories, Mass transfer in fluidized beds, Flow past solids and boundary layers, Simultaneous heat and mass transfer. [8]

Unit II

Absorption and Stripping: Equipments, Gas-liquid equilibria, Henry's law, Selection of solvent, Absorption in tray column, Graphical and analytical methods, Absorption in packed columns, HTU, NTU &HETP concepts, Design equations for packed column, Absorption with chemical reaction and mass transfer. [8]

Unit III

Humidification and Dehumidification: Vapour liquid equilibrium and enthalpy for a pure substance, Vapour pressure temperature curve, Vapour gas mixtures, Definition and derivations of relationships related with humidity Fundamental concept of humidification, Dehumidification and water cooling, Wet bulb temperature, Adiabatic and non-adiabatic operations, Evaporative cooling ,Classification and design of cooling towers. [8]

Unit IV

Drying: Solid-gas equilibria, Different modes of drying operations, Definitions of moisture contents, Types of batch and continuous dryers, Rate of batch drying, Time of drying, Mechanism of batch drying, Continuous drying, Design of continuous dryers. [8]

Unit V

Crystallisation: Equilibrium yield of crystallization ,Heat and mass transfer rates in crystallization,Theories of crystallization, Factors governing nucleation and crystal growth rates, Controlled growth of crystal., Classification and design of crystallizers. [8]

Text Books

1. Treybal, R "Mass Transfer Operations", 3rd ed. New York: McGraw-Hill, (1980).
2. Sherwood T. K., Pigford R. L. and ilke P. "Mass Transfer" McGraw Hill (1975).

Reference Books

1. Foust A. S. et.al., "Principles of Unit Operations" John Wiley (1980).
2. Geankoplis, C.J.. "Transport Processes and Unit Operations", 3rd ed. Prentice Hall. (1993)

SUBJECT CODE: ECH 502 COURSE TITLE: CHEMICAL REACTION ENGINEERING – II

COURSE OUTCOME:

On completion of this course, the students will be able to

1. Analyze the various contacting pattern and predict the rate equation for various heterogeneous reaction system.
2. Classify catalysts and predict properties of catalyst and its characteristics.
3. Understand the concept behind reaction and diffusion through porous catalyst and stability of reactors.
4. Design various type of reactors and predict the rate controlling step for different reactions.
5. Understand the mechanism of biochemical reaction system.

Syllabus

Unit I

Reactor Models

Design equations for batch, continuous and semi batch reactors, Selectivity and yield. Noncatalytic heterogeneous reactions ; Rate equations for heterogeneous reactions. [8]

Unit II

Heterogeneous Catalysis

Nature of catalysis, Adsorption isotherms, Mechanism of catalytic reactions, Physical properties of solid catalysts. Preparation testing and characterization of catalysts, Catalyst selection, Catalyst poisoning. [8]

Unit III

External Transport Process

Reaction and diffusion within porous catalysts, Effective diffusivity, Thermal conductivity and effectiveness factor. Reactor choice for single and multiple reactor system and recycle reactor

Stability of Reactors

Non - isothermal design of ideal reactor, Hot spot in tubular reactor, Steady state multiplicity and effect of operating variables on the stability of C.S.T.R. [8]

Unit IV

Reactor Design

Progressive conversion and un-reacted core model, Determination of rate controlling step, application to design, fluidized bed reactions Design of solid catalytic reactor, batch, CSTR and tubular reactor. Design of fixed bed and fluidized bed reactors. [8]

Unit V

Non elementary reactions and reactor design, biochemical reaction system, Enzyme fermentation, Microbial fermentation, polymerization reactors [8]

Text Books

1.Levenspiel, O.. "Chemical Reaction Engineering", 3rd ed. New York John Wiley (1998)

Reference Books

1. Fogler, H.S. "Elements of Chemical Reaction Engineering", 4th ed. Prentice Hall (1997).
2. Smith, J. "Chemical Engineering Kinetics ", 3rd edition. McGraw-Hill, . (1990).

SUBJECT CODE: ECH 503 COURSE TITLE: CHEMICAL TECHNOLOGY – II (INORGANIC)

COURSE OUTCOME:

On completion of this course, the students will be able to

1. Understand the production of various products of chlor-alkali industry.
2. Discuss the production and consumption pattern of sulfur and phosphorus industry.
3. Describe the various manufacturing and technological development taking place in nitrogen and fertilizer industries.
4. Understand the application and production of industrial gases in chemical industries.

A study of the following chemical industries in relation to their current status (Indian and global), Production and consumption pattern, manufacturing process, latest technological developments, Engineering problems viz pollution control, material of construction, corrosion and economic status should be under taken. These industries have been distributed in the following units :-

Syllabus

Unit I

Chlor-alkali industry: Common salt, Caustic soda and Chlorine, Soda Ash, Hydrochloric acid. [8]

Unit II

Sulfur Industry: Sulfur and sulfuric acid,Oleum Phosphorus Industry: Phosphorus, Phosphoric acid and super phosphates [7]

Unit III

Nitrogen Industry: Ammonia, Nitric acid, Urea and other nitrogen fertilisers, Mixed fertilisers (SSP, TSP, NPK ,KAP ,DAP, Nitrophosphate) Bio fertilizers. [8]

Unit IV

Industrial Gases: Oxygen, Nitrogen, Hydrogen Inert gases, Syngas, Cement. [7]

Text Books

1. Dryden, C. E. "Outlines of Chemical Technology" (Edited and Revised by M.Gopal Rao and Sittig .M) East West Press. ,New Delhi,3 rd Edition(1997).
2. Austin G. T » Shreve's Chemical Process Industries", 5th ed., McGraw Hill.(1984)
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Reference Books

1. Faith, W. L., Keyes, D. B. and Clark, R. L., "Industrial Chemicals" John Wiley.(1975).
2. Kirk and Othmer, "Encyclopaedia of Chemical Technology" Wiley (2004).
3. Pandey G.N &Shukla.S.D, "Chemical Technology Vol - I" Vikas publication.

SUBJECT CODE: ECH504 COURSE TITLE: PROCESS INSTRUMENTATION

COURSE OUTCOME:

On completion of this course, the students will be able to

1. Explain the importance, classification, static and dynamic characteristics of instruments.
2. Explain the principle, working, advantages and disadvantages of various instruments used for temperature measurement and examine the use of instruments for a particular application.
3. Explain the principle, working, advantages and disadvantages of various instruments used for pressure measurement and examine the use of instruments for a particular application

4.Explain the principle, working, advantages and disadvantages of various instruments used for flow level and viscosity measurement and examine the use of instruments for a particular application.

Syllabus

Unit I

Importance of measuring of Instruments in Process Control, Classification of Instruments, Elements of an Instruments, Static & Dynamic Characterization of Instruments, Errors in measurements & Error Analysis, Selection of instrument for a particular Measurement, transducers.[8]

Unit II

Measurement of Temperature: Thermocouples, Resistance Thermometer, Expansion Thermometers, Pyrometers. [6]

Unit III

Measurement of Pressure & Vacuum, Hydrostatic type, Elastic Element type, Electrical Type and other type of instruments like Neleod Gauge, Thermocouple gauge, Knudson Gauge, Ionization Gauge. [8]

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Unit IV

Instruments for Measurement of Flow rate, level & Viscosity, Variable Area & variable head flow meters, Volumetric and Mass flow rate meters, Linear velocity measurement systems, Anemometers, Pressure type , Resistance & Capacitance type, Sonic & Ultrasonic, Thermal type Level meters. Viscometers: Redwood, Saybolt, Engler, Cup & Cone type, Rheo& other types of viscometers, [8]

Books

1. Eckman, D.P., Industrial Instrumentation, Wiley Eastern Ltd., New York 1990.
2. Jain, R.K., Mechanical and Industrial Measurements, Khanna Publishers.

ECH 551: MASS TRANSFER OPERATIONS LAB-I 0 0 3

1. Study the performance and determination of Equilibrium relationships
2. Mass transfer coefficients,
3. Diffusion coefficients,
4. Separation factors of the experiments with differential distillation,
5. Flash vaporization, vapour liquid equilibrium,
6. Liquid – liquid extraction,
7. Solid –liquid extraction,
8. Ion exchange and membrane separation.

ECH 552: PROCESS INSTRUMENTATION LAB 0 0 3

1. Calibration of thermocouple/Bimetallic thermocouple/Resistance thermocouple.

2. Calibration of Pressure gauge/ Pnuematic pressure recorder/ Differential pressure recorder.

3. Calibration of Orificemeter/ Venturimeter / Rotameter/ Gas flow meter.

4. Estimation of viscosity by Redwood/ Saybolt/ Ostwald viscometer.

5. Calibration of pH meter.

6. Calibration of Conductivity meter.

EAS 551: COMPUTER BASED NUMERICAL METHODS LAB 0 0 3

Use of following Techniques in C/C++ Language

1. Solution of single non-linear algebraic equations by Newton Raphson method.

2. Solution of single non-linear equations by Regulafalsi method.

3. Solution of system of linear simultaneous by Gauss Elimination method.

4. Solution of system of linear simultaneous equation by gauss seidel method and successive over relaxation method.

5. Solution of single first order ordinary differential equations by fourth order Runge-Kutta method.

6. Solution of Heat equations (Parabolic equations) by finite difference method.

7. Solution of Laplace equations (elliptic equation) by finite difference method.

8. Solution of wave equations (Hyperbolic equation) by finite difference method.

9. Finding Newton's interpolatory polynomial for n points.

10. Finding Newton's interpolatory polynomial based on finite difference table for n points.

11. Simpson's 3/8-rule.

SUBJECT CODE:ECH 601 COURSE TITLE:MASS TRANSFER OPERATIONS-II

COURSE OUTCOME:
On completion of this course, the students will be able to

1. understand the extent of separation achived for a binary or multi-component system undergoing flash,steam, batch or fractional distillation.
2. Apply mathematical equations to calculate number of theoretical stages required for a given extent of seperation by liquid-liquid or solid-solid extraction for cross current and countercurrent flows.

3. Analyze the similarity of mass, heat and to perform the calculations by phychometric chart.
4. Analyze the design contactor for gass absorption system, constant rate drying system and crystallizers.

Syllabus

Unit I

Distillation

Pressure-composition, Temperature-concentration, Enthalpy-concentration diagrams for ideal and non-ideal solutions, Raoults law and its application, Maximum and minimum boiling mixtures, concept of relative volatility, Single Stage Distillation Differential distillation, Flash vaporization, Vacuum, molecular and steam distillation. [8]

Unit II

Continuous Distillation of Binary Mixtures

Multistage contact operations, Characteristics of multistage tower, McCabe Thiele method, PonchonSavarit method, Reflux, maximum, min. and optimum reflux, Use of open steam, Tray efficiency, Determination of height and column diameter, Multistage batch distillation; Principles of azeotropic and extractive distillation, Introduction to multicomponent distillation system. [8]

Unit III

Liquid-Liquid Extraction

Ternary liquid equilibria, Triangular graphical representation concept of theoretical or ideal stage, Equipment used for single stage and multistage continuous operation; Analytical and graphical solution of single and multistage operation Super critical fluid extraction. [8]

Unit IV

Solid /Liquid Extraction

Leaching, Solid liquid equilibrium, Equipment used in solid-liquid extraction,Single and multistage cross current contact and counter current operations. Concept of an ideal stage, Overall stage efficiency, Determination of number of stages. [8]

Unit V

Adsorption

Description of adsorption processes and their application, Types of adsorption, Nature of adsorbents adsorption equilibria and adsorption hysterises, Stage wise and continuous contact adsorption operations, Determination of number of stages, Equipments;
Ion exchange, Equilibrium relationship, Principle of ion-exchange, techniques and applications, Principles and application of dialysis, osmosis reverse osmosis, thermal diffusion, sweep diffusion. [8]

Text Books

1. Treybal, R "Mass Transfer Operations", 3rd ed. New York: McGraw-Hill, (1980).
2. Sherwood T. K., Pigford R. L. and Wilke P. "Mass Transfer" McGraw Hill (1975).

Reference Books

1. Foust A. S. et.al., "Principles of Unit Operations" John Wiley (1980).
2. Geankoplis, C.J.. "Transport Processes and Unit Operations", 3rd ed. Prentice Hall. (1993)

SUBJECT CODE: ECH 602 COURSE TITLE:PROCESS DYNAMICS AND CONTROL.

COURSE OUTCOME:

On completion of this course, the students will be able to

1. Apply the concept of dynamic systems response to pulse, step, and sinusoidal inputs in a process control system.
2. Describe single-loop feedback control of processes - concepts, terminology, methods, and performance.
3. Explain the mode of control action and its response on closed loop control system.
4. Analyze the stability limits for a system, with or without control.
5. Evaluate the frequency response of a system and control the system by tuning the process.

Syllabus

Unit I :

Introduction to Process control systems, Regulator & Servo control, Feed Forward & Feed backward control, Negative & Positive Feedback Control, variables & Physical Elements of a Control system, Physical, Block & Signal Flow Diagram. Use of Laplace & Inverse Laplace Transformation is study of Process Dynamics.

Unit II

Dynamic Modeling of a Process, Dynamic behavior of First order systems and First order systems in series. Dynamic behavior of second & higher order system for various kind of inputs, Linearization of nonlinear system, Transportation & Transfer Lag.

Unit III

Modes of control action, Controllers & Final control Elements, Reduction of Block & Signal Flow Diagrams, Closed loop transfer function and response of closed loop control system for various type of control actions.

Unit IV

Stability analysis, Rouths criterion, Root locus Analysis, Frequency Response Analysis & Design of Controllers for optimum Performance.

Unit V

Advanced control strategies, cascade control, Feed forward control, Tuning Rules for Feed Forward & Feed backward control, Ratio control, optimum controller Tuning, Ziegler Nichol & Cohen Coon settings.

Test Books :

1. Process system Analysis & Control, D.R. Coughanoowr, McGraw Hill Publication.

Reference Books :

1. Process Control. Peter Harriot, Tata McGraw Hill.
2. Process control, Staphno polies, Prentic Hall India Ltd.

SUBJECT CODE: ECH 603 COURSE TITLE:PROCESS EQUIPMENT DESIGN

COURSE OUTCOME:

On completion of this course, the students will be able to

1. Knowledge of basics of process equipment design and important parameters of equipment design.
2. Design pressure vessels subjected to internal and external pressures.
3. Build a bridge between theoretical and practical concepts used for designing the equipment in any process industry.
4. Create the design of equipments using mechanical concept.

Syllabus

Unit I

Introduction to various mechanical properties of materials to be used as material of construction, resistance of metals to corrosion under varying conditions of temperature and pressure etc. Application and use of various codes and standards in design. [6]

Unit II

Design of non-pressure storage vessel, tall vertical vessels, unfired pressure vessels with internal pressure ,Design of unfired pressure vessels with external pressures, end closures, flat plates, domed ends, torispherical, ellipsoidal, hemispherical and conical ends. Design of nozzles,openings and reinforcements, Bolts, flanges, gaskets . [10]

Unit III

Bolted flanges, pipe line design and process design of a few equipments like heat Exchangers, Evaporators, Distillation columns, Absorbers, Reactors and Dryers . [8]

Unit IV

Mechanical design of selected process equipments such as heat exchangers, Evaporators, Distillation columns, Absorbers, Reactors and Dryers and Crystallizers; Use of softwares for design of equipments. [6]

Text Books

1. Peters Max. S., Timmerhaus Klaus D.and Ronald E West “Plant Design and Economics for Chemical Engineers”.2003 V Edition McGraw Hill.
2. Coulson, J. M. and Richardson J. F. “Chemical Engineering”, vol. 6 Pargamon Press. (1989).
3.Brownel and Young, “Process Equipment Design ”.Wiley (1968).

Reference Books

1. Indian and American Codes Used in Designing of equipments (TEMA and IS Codes)
2. Evans, F. L., "Equipment Design Handbook", Gulf Publishing Company.(1979).

ECH 651: MASS TRANSFER LAB-II **0 0 3**

Study the performance and determination of equilibrium relationships, mass transfer coefficient, Separation factors of the experiments with gas diffusion, packed bed absorption, bubble gas absorption, humidification and dehumidification, cooling tower, tray dryers, crystallization and adsorption.

ECH 652: PROCESS DYNAMICS AND CONTROL LAB **0 0 3**

1. To study the response, time constant of thermocouple/ Bimetallic thermometer.
2. To study the response of a liquid level tank system
3. To study the response of a two tank non-interacting system
4. To study the response of a two tank interacting system.
5. To study the response of a stirred tank heater system
6. To study the characteristics of an on-off controller.
7. To study the characteristics of a PI/PID pneumatic / electronic controller.
8. To study the performance of a closed loop control system containing controller, final control element, measuring element.
9. Calibration of temperature and pressure measuring instruments
10. Analysis of solution by UV/VIS spectrophotometer

ECH 653: ENERGY LAB **0 0 2**

1. Estimation of net & gross calorific value of coal sample using Bomb Calorimeter
2. Estimation of net calorific value of petroleum sample using Bomb Calorimeter
3. Derivation of kinematic viscosity by Saybolt Viscometer (Universal and Furol)
4. Determination of flash and fire points by Penskey Marten apparatus
5. Estimation of carbon residue
6. Efficiency of solar cell
7. Proximate analysis of Coal
8. Performance of solar water pump
9. Performance of solar regenerator

ECH- 654: EQUIPMENT DESIGN **0 0 2**

Practice to design various equipments with 'to scale' drawing and use of softwares for the design.

SUBJECT CODE: ECH 011 COURSE TITLE:ENERGY RESOURCES UTILIZATION

COURSE OUTCOME:

On completion of this course, the students will be able to

1. Discuss the energy scenario and classification of various energy sources.
2. Demonstrate an overview of the main sources of renewable energy.
3. Describe the principles and technologies for energy conversion by alternative sources of energy.
4. Outline the technologies that are used to harness the power of coal.
5. Outline the technologies that are used to harness the power of coal.

Syllabus

Unit I

Energy Scenario

Indian and global, energy crisis, Classification of various energy sources, Renewable and non-renewable energy sources, Remedial measures to some energy crisis.

Energy Conservation

Energy: Biogas plants and their operation, Biomass and its conversion routes to gaseous and liquid fuels. Wind energy, its potential and generation by wind mills, [8]

Unit II

Alternative Sources of Energy

Fuel cell ,Solar Energy : Photo thermal and photovoltaic conversion and utilisation methods , solar water heating , cooking , drying and its use for other industrial processes , solar cells their material and mode of operation . direct and indirect methods solar energy storage , sensible heat and latent heat storage materials Solar ponds .

Bio energy, biogas plants and their operation , biomass and its conversion roots to gaseous and liquid fuels ,wind energy , its potential and generation by wind mills [8]

Unit III

Hydroelectric potential, its utilization & production, Geothermal energy its potential status and production, Nuclear energy : Status, nuclear raw materials, nuclear reactors and other classification, Generation of Nuclear power, Nuclear installations in India and their capacity of generation, Limitations of nuclear energy, Reprocessing of spent nuclear fuel, Cogeneration of fuel and power, Energy from tidal and ocean thermal sources, MHD systems. [8]

Unit IV

Fossil and Processed Fuel

Coal its origin and formation, Coal analysis, Coal classification, Coal preparation, Coal washing and coal blending, Coal carbonization, Treatment of coal gas and recovery of chemical from coal tar, Coal gasification, liquid fuel synthesis from coal, CBM. [8]

Unit V

Petroleum crude , Types of crude ,emergence of petroleum products as energy, Gaseous Fuels: Natural gas, Water gas, producer gas, L.P.G., bio- gas, coke oven gas, blast furnace gas, LNG ,CNG,Gas hydrates ,GTL Technology (gas to liquid), Biodisel. [8]

Text Books

1. Brame J.S.S. and King J.G., Edward Arnold "Fuel Solid, Liquid and Gases" Edward Arnold (1967).
2.Sukhatme S.P, "Solar Energy - Principles of Thermal Collection and Storage",2ndEd., Tata McGraw- Hill.,(1996).

ECH 012: ENERGY MANAGEMENT **3 1 0**

Syllabus

Unit I

Energy Scenario Commercial & Non commercial energy, primary energy resources, commercial energy production, final energy consumption, energy need of growing economy, long term energy scenario, energy pricing, energy sector reform, energy & environment, energy conservation and its importance, re- structuring of the energy supply sector, energy strategy for future, energy conservation act. [8]

Unit II

Energy Management & Energy Planing Definition & significance, energy strategy, energy policy & energy planning, two sides of energy management, sectors of supply side energy management, objective of energy management, hierarchical levels of supply side energy management, trade off b/w energy management, energy strategies & energy planning, energy & economy, essential imperatives & steps in supply side energy planning, energy planning flow for supply side, essential data for supply side energy planing, infrastructure planning, transportation of energy, per capita energy consumption, imperatives & steps in user side energy planning, energy management & control system for demand side, seven principal of energy management, energy policy of a supply organization & demand side organization, organization for energy management, training & human resource development, motivation. [8]

Unit III

Energy Audit & Energy Monitoring, Targeting and Conservation Introduction, need, types & procedure of energy audits, modern techniques and instruments for energy audit. Defining monitoring & targeting, element of monitoring & targeting, data & information analysis, techniques- energy consumption, production & cumulative sum of differences (CUSUM). Energy conservation opportunity, electrical & thermodynamic ECOs, ECOs in chemical process industries, waste management & recycling of discard material and energy. [8]

Unit IV

Advancement In Technologies & Future Energy Alternatives Recent advancement in energy technology towards 21st century, transport of energy, ethanol as a fuel. Fusion – introduction potential, condition for fusion, magnetic confinement fusion reactor, cold fusion laser induced fusion. Biomass –introduction, municipal waste, biomass conversion, wood combustion Geothermal energy – introduction, origin, nature, resources and exploration, environment impact, low temperature geothermal resources. [8]

Unit V

Case Studies Energy conservation in alcohol industry. Energy conservation in fertilizer industry and pulps & paper industry. Energy conservation in different units of refinery likes FCCU, HCU & ADU. [8]

Text Books

1. Murphy W.R. and Mckay G., Energy Management(BH)

2. Hinrich & Kleinbach "Energy : its use and the environment" III ed. Harcourt.

3. Boyle "Renewable Energy : Power for a sustainable future" Oxford.

4. Rao S. & Parulckar B.B. "Energy technology" khhanna publisher

5. Capenart & Turner " Guide to energy management " 6 ed. Keinnedu fairmant press.

ECH 013 : ENERGY EFFICIENCY AND ENERGY CONSERVATION 3 1 0

Syllabus

Unit I

Energy scenario, Classification of energy sources, Need for conserving energy, Government initiative for conserving energy (Role of Bureau of Energy Efficiency, Energy conservation bill 2001), Energy efficiency based on first and second laws of thermodynamics.

Unit II

Thermodynamic analysis of chemical processes Energy audit, Objectives of energy audit, Energy audit team, Methodology, Types of energy auditPreliminary and detailed, Proposed measures for energy conservation with cost-benefit analysis.

Unit III

Equipment-oriented approaches for energy conservation-Fired heater, Boiler, Evaporators, Distillation column, absorption/stripping column, Dryer, Liquid-liquid extraction column Waste heat recovery: Sources of waste heat, Feasibility of waste heat recovery, Types of heat recovery equipments, Applications.

Unit IV

Pinch technology, Energy targets, Composite curves, Process pinch, Pinch principles, Grand composite curves and process utility interface, Uses of pinch analysis in chemical process industries.

Unit V

Energy conservation opportunities in chemical process utilities - Steam systems, Compressed air systems, Insulation Cogeneration, Cogeneration systems

Text Books

1. Hinrich & Kleinbach "Energy : its use and the environment" III ed. Harcourt.

2. Boyle "Renewable Energy : Power for a sustainable future" Oxford.

3. Rao S. & Parulckar B.B. "Energy technology" khhanna publisher

4. Capenart & Turner " Guide to energy management " 6 ed. Keinnedu fairmant press.

SUBJECT CODE:ECH 021 COURSE TITLE:OPTIMIZATION TECHNIQUE IN CHEMICAL ENGINEERING

COURSE OUTCOME:

On completion of this course, the students will be able to

1. Apply the knowledge of optimization to single and multivariable unconstrained and constrained problems.
2. Analyze the optimization criterion and understand methods for solving problems.
3. Apply simplex method for linear optimization problems.
4. Apply different methods of optimization and to suggest a technique for specific problem.

Syllabus

Unit I

Analytical Method Necessary and sufficient conditions for optimum in single and

multi variable unconstrained and constrained problems. [7]

Unit II

Unconstrained One Dimensional Search Newton, Quasi-Newton and Secant method for unidimensional search, Region elimination methods (Golden Section, Fibonacci, Dichotomous. etc.) [7]

Unit III

Linear Programming, Graphical simplex method, revised simplex method, duality and transportation problems. Unconstrained Multi Variable Search, Direct methods, Indirect method. [8]

Unit IV

Finite difference approximation, Dynamic Programming, Principle of optimality, Discrete and continuous dynamic programming. [8]

Books Recommended

1. T.F. Edgar and D.M. Himmelblau Optimization of Chemical Processes – McGraw Hill (1989)
2. K. Urbanier and C. McDermott - Optimal Design of Process Equipment – John Wiley (1986)

SUBJECT CODE: ECH 022 COURSE TITLE : COMPUTATIONAL FLUID DYNAMICS

COURSE OUTCOME:

On completion of this course, the students will be able to

1. Explain the need of CFD, classify and illustrate various types of flows and their modelling.
2. Discuss the need of grid generation and justify grid type usage in problem and to be able to apply Finite Difference Method and solve CFD problems.
3. Apply Finite volume method and solve CFD problems and identify &investigate various boundary conditions.
4. Solve CFD problems based on Flow in a sudden pipe contraction / expansion, flow and heat transfer in a complex tubes and channels, reactive flow, multiphase flow , and turbulent flow processes.

Syllabus

Unit I

Basic Concepts of Fluid Flow: Philosophy of computational fluid dynamics, conservation principles of mass, energy, and momentum, simplified flow models such as incompressible, inviscid, potential and creeping flows, classification of flows.

Turbulence and its Modelling: Transition from laminar to turbulent flow, Effect of turbulence on timeaveraged Navier-Stokes equations, Characteristics of simple turbulent flows, Free turbulent flows, Flat plate boundary layer and pipe flow, Turbulence models, Mixing length model,The k-e model, Reynolds stress equation models, Algebraic stress equation models [6]

Unit II

Grid Generation: Structured and unstructured grids, choice of grid, general transformation of equations, some modern developments in grid generation in solving the engineering problems.

Finite Difference Method: Discretization of ordinary and partial differential equations, approximation of first, second and mixed derivatives, implementation of boundary conditions, discretization errors, applications to the engineering problems.[7]

Unit III

Finite Volume Method: Discretisation methods, approximations of surface integrals and volume integrals, interpolation and differentiation practices, implementation of boundary conditions, applications to the engineering problems. Introduction, one-dimensional steady state diffusion, two-dimensional diffusion problems, three-dimensional diffusion problems. The Finite Volume Method for Unsteady Flows and Implementation of Boundary Conditions: One-dimensional unsteady heat conduction, [10]

Unit IV

Special Topics: Flow in a sudden pipe contraction / expansion, flow and heat transfer in a complex tubes and channels, reactive flow, multiphase flow , and turbulent flow processes. [7]

Suggested Books:

1. Anderson Jr J. D., "Computational Fluid Dynamics: The Basics with Applications", McGraw Hill. 1995

2. Muralidhar K. and Sundararajan T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House. 2003

3. H. K. Versteeg and W. Malalasekera, An introduction to computational fluid dynamics: the finite volume method , Longman scientific & technical publishers 2007

4. Ferziger J. H. and Peric M., "Computational Methods for Fluid Dynamics", 3rd Ed., Springer. 2002

5. Ranade V. V, "Computation Flow Modeling for Chemical Reactor Engineering", Academic Press. 2002

ECH 023: STATISTICAL DESIGN OF EXPERIMENTS 2 1 0

Syllabus

Unit I

Introduction: Strategy of experimentation, basic principles, guidelines for designing experiments; Simple Comparative Experiments: Basic statistical concepts, sampling and sampling distribution, inferences about the differences in means, randomized and paired comparison design. Experiments with Single Factor: Analysis of variance, Covariance and analysis of covariance, analysis of fixed effects model, model adequacy analysis, non-parametric methods. [8]

Unit II

Design of Experiments: Fundamental and types of Design of Experiment, Randomized blocks, latin squares, and related design, factorial design, two-factor factorial design, blocking in a factorial design, the 22 & 23 factorial design, the general 2k factorial design, blocking and compounding in the 2k factorial design, two-level, three level and mixed level factorial and fractional factorial designs. [6]

Unit III

Parameter Estimation: Linear regression models, estimation of the parameters in linear regression models, hypothesis testing in multiple regression, non-linear regression, logistic and weighted regression, Chi-squared tests, confidence intervals in multiple regression, prediction of new response observations, regression model diagnostics, testing for lack of fit. [8]

Unit IV

Response Surface Methods: Central composite and Box-Behnken designs, method of steepest ascent, analysis of a second-order response surface, experimental designs for fitting response surfaces, mixture experiments, Simultaneous optimization of several responses, Simplex method, evolutionary operation, robust design. Experiments with Random Factors: Random effect model, two factor factorial with random factors, two-factor mixed model, sample size determination with random effects, approximate F tests. Design and Analysis: Nested and split-plot design, non-normal responses and transformations, unbalanced data in a factorial design.[8]

Suggested Books:

1. Lazic Z. R., "Design of Experiments in Chemical Engineering: A Practical Guide", Wiley,2005.

2. Antony J.," Design of Experiments for Engineers and Scientists," Butterworth Heinemann, 2004,

3. Montgomery D. C., "Design and Analysis of Experiments", 5th Ed., Wiley, 2004.

ECH 024: PROCESS FLOW SHEET SIMULATION 2 1 0

Unit I

Introduction to Process Simulation: Background and history of process simulation; Steady State and Dynamic Simulation; Different approaches to process simulation; modules and components in a process simulation package, integration of simulation tools, structure and functionality of commercial simulation tools, selection of flowsheet and simulation software. Process Flow sheeting: Approaches to flowsheeting, collection and estimation of thermo-physical properties for the chemical species of the system, thermo-physical properties banks, Flow sheet presentation, manual flow sheet calculations, computer aided flow-sheeting, manual calculations with recycle streams, partitioning and tearing a flowsheet.[7]

Unit II

Fundamentals of systems engineering: system definition, system properties, aggregation/decomposition, hierarchies of systems; introduction of canonical modeling concepts: devices, connections, equations, variables; formalizing the modeling process: methods of structuring complex chemical processes, procedures for process modeling; degrees of freedom in a flow sheet. numerical properties of the model equations, numerical methods for steady-state and dynamic systems, Differential Algebraic Equations; Synthesis of reaction systems and synthesis of azeotropic separation systems.[7]

Unit III

Processing Simulation with softwares such as: ASPEN PLUS/Hysis/PRO II/Design II/UniSim/OLI Pro/Aspen Custom Modeler/TK-Solver: Introduction to the Simulation Package; Features of simulation packages; Introduction to the simulation package Graphical User Interface; Example-1: Flashing of Light Hydrocarbons; Survey of unit operation models; Example-2: Vinyl chloride monomer (VCM) flowsheet. Flowsheet Calculations and Model Analysis Tools: Sensitivity and case-study runs ; Design specifications and calculator blocks ; Example-3: VCM flowsheet sensitivity run / design-spec run. Inorganic chemicals and electrolyte modeling; Example-4: sour water systems (CO2 and H2S removal for example);[8],

Unit IV

Physical Properties: Overview of physical property system ; Property model specifications ; Property data requirements and input; Physical property analysis; Example-1: Introducing a non-databank component. Multistage Separation: RADFRAC: Rigorous rating and design fractionation model; Example-2: Using RADFRAC in the VCM flowsheet. Introduction to ICARUS(an economic evaluation package inside ASPEN PLUS), Flowsheet Convergence: Example-3: VCM flowsheet convergence, Introduction to overall Plant automation through simulation, molecular modeling and how it will compliment standard simulators and dynamic simulation. Case Study: Design and simulation of some of the inorganic and organic process plants such as sulphuric acid, ammonia.[8]

Suggested Books and Resources:

1.Dimian A. C., "Integrated Design and Simulation of Chemical Processes", Elsevier,2003
2.Westerberg, A. W., Hutchison, H. P., Motard, R. L. & Winter, P., "Process Flowsheeting", Cambridge University Press,1979.

3.Kumar, A., "Chemical Process Synthesis and Engineering Design", Tata McGraw Hill,1981.
4.K. M. Hangos and I. T. Cameron, "Process Modelling and Model Analysis", Academic Press,2001

5.W. F. Ramirez, "Computational Methods for Process Simulation", 2nd ed., Butterworths,1997
Westerberg, et al, "Process Flow Sheeting", Cambridge University Press,1990
7.Resources:

æ SCILAB, available at http://www.scilab.org, is an open-source simulation package, quite similar to MATLAB. æ Netlib online repository for numerical and scientific computing: http://www.netlib.org/ æ Numerical Recipes: The art of scientific computing website: http://www.nr.com/ æ CANTERA, Object-Oriented Software for Reacting Flows: http://www.cantera.org/ æ Practice problems: http://www.che.eng.kmutt.ac.th/cheps/ChE656.htm

SUBJECT CODE: EOE081 **COURSE TITLE:NCER**

COURSE OUTCOME:
On completion of this course, the students will be able to

1. Identify various forms of non-conventional energy resources, their availability, classification, relative merits and demerits. Understand the theory of solar cells, solar materials, solar cell power plants.

2. Understand the various ways of utilization of solar thermal energy (solar radiation), various forms of solar thermal collectors and their materials, applications and performance, solar thermal power plants, thermal energy storage for solar heating and cooling, limitations.
3. Identify and analyse the various types of the geothermal energy resources, thermodynamics of geo-thermal energy conversion-systems, environmental considerations. Understand the working of principle of various types of fuel cells and MHD Power plant, their performance and limitations.
4. Understand the thermo-electrical and thermionic Conversion systems: Principle of working, performance and limitations. Wind Energy: Wind power and its sources, site selection, criterion, momentum theory, classification of rotors, concentrations and augments, wind characteristics. performance and limitations of energy conversion systems.
5. Analyse the availability of bio-mass and its conversion theory and also waste recycling power plants. Understand the working principle, availability, performance and limitations of Ocean Thermal Energy Conversion (OTEC) systems, wave and tidal wave energy power Plants.

SUBJECT CODE: ECH 701 COURSE TITLE:PROCESS MODELLING AND SIMULATION

COURSE OUTCOME:
On completion of this course, the students will be able to
1. Understand mathematical modelling of unit operations and unit processes.
2. Understand models of process and steady state models equipment used in Chemical Engineering.
3. Apply solution strategies to Differential Algebraic Equation and Partial Differential Equation arising in Steady State process models.
4. Understand unsteady state process models and review their solution strategies.
5. Explain Process flow sheet simulation and understand approaches to flow sheet modelling.

Syllabus

Unit I

Introduction to mathematical modeling; Advantages and limitations of models and applications of process models of stand-alone unit operations and unit processes; Classification of models – Simple vs. rigorous, Lumped parameter vs. distributed parameter; Steady state vs. dynamic, Transport phenomena based vs. Statistical; Concept of degree of freedom analysis. [8]

Unit II

Simple examples of process models; Models giving rise to nonlinear algebraic equation (NAE) systems, - steady state models of flash vessels, equilibrium staged processes distillation columns, absorbers, strippers, CSTR, heat exchangers, etc.; Review of solution procedures and available numerical software libraries. [8]

Unit III

Steady state models giving rise to differential algebraic equation (DAE) systems; Rate based approaches for staged processes; Modeling of differential contactors - distributed parameter models of packed beds; Packed bed reactors; Modeling of reactive separation processes; Review of solution strategies for Differential Algebraic Equations (DAEs), Partial Differential Equations (PDEs), and available numerical software libraries. [8]

Unit IV

Unsteady state (time dependent) models and their applications; Simple dynamic models of Batch reactors, Adsorption columns, Multistage separation systems; Model reduction through orthogonal collocation; Review of solution techniques and available numerical software libraries. [8]

Unit V

Introduction to flow sheet simulation; Sequential modular approach; Equation oriented approach; artitioning and tearing; Recycle convergence methods; Review of thermodynamic procedures and physical property data banks. [8]

Text Books

1. Luyben W.L., "Process Modeling, Simulation, and Control for Chemical Engineering", Wiley.
2. M.M. Denn, "Process Modelling", Wiley, New York, (1990).

Reference Books

1. Hussain Asghar, "Chemical Process Simulation", Wiley Eastern Ltd., New Delhi, (1986)
2. C.D. Holland and A.I. Liapis, "Computer Methods for Solving Dynamic Separation Problems", +McGraw Hill, (1983).
3. C.D. Holland, "Fundamentals of Modelling Separation Processes", Prentice Hall, (1975)
4. S.M. Walas, "Modelling with Differential Equations in Chemical Engineering", Butterworth, (1991)
5. M.E. Davis, "Numerical Methods and Modelling for Chemical Engineers", Wiley, New York(1984)

SUBJECT CODE: ECH 702 COURSE TITLE:PROCESS DESIGN AND ECONOMICS

COURSE OUTCOME:

On completion of this course, the students will be able to

1. Understand the concepts of process development and plant design.
2. Explain the use of depreciation, taxes and insurance, and interest in the cost engineering.

3. Evaluate the project cost including capital investment, total product cost, breakeven point and profitability.
4. Understand the nature of optimization and use of various programming methods for optimum conditions.
5. Explain the optimum design of equipments based on economics and process considerations.

Syllabus

Unit I

Process Development

Process selection, study of alternative processes, pilot plant, Scale up methods, Flow sheet preparation, sketching techniques, Equipment numbering, Stream designation, Material and energy balances.

Plant Design

Design basis ,Process selection -Selection of equipment, specification and design of equipment's, material of construction, Plant location, Plant layout and installation, Safety, Start up, Shutdown and Operating guidelines. [8]

Unit II

Cost Engineering

Time value of money and equivalence, Interest, cost comparisons by present worth, Annual equivalent cost and capitalised cost methods, Uniform gradient and series. Depreciation, Taxes and Insurances Nature of depreciation, Methods of determining depreciation, depreciation rates in current Indian situation, Types of taxes and insurance's, Procedure for cost comparison 40 after taxes. [8]

Unit III

Cost Estimation

Types of cost estimation, capital investment cost, fixed capital cost, working capital cost, start-up costs, process equipment cost estimation, cost index, Equipment costs due to inflation, Battery limit investments, estimation of plant cost, Estimation of total product cost, Manufacturing cost, General expenses.

Profitability

Criteria of profitability, Payout period, Return on investment, Present value, Cash flow analysis, Alternative investment analysis, Sensitive analysis in project profitability. [8]

Unit IV

Economic Optimization and Optimum Design

Nature of optimisation, Uni-variable and multivariable systems, Analytical, graphical and incremental methods of solution, LaGrange multiplier method, Linear programming and dynamic programming establishing optimum conditions, Break even chart for production schedule, Optimum production rates in plant operation, Optimum conditions in batch, cyclic and semicyclic operation, Sensitivity and response analysis.[8]

Unit V

Optimisation of Different Process Equipment

Viz., transportation systems, heat exchangers, evaporators, mass transfer equipments and reactors. Determination of height and diameter of different process equipments at conditions of optimum cost .Pinch Technology analysis. Preparation of techno-economic feasibility report. [8]

Books Recommended

1. Peters M., Timmerhaus K. & Ronald W., Plant Design & Economics for Chemical Engineers, McGraw Hill
2. James R Couper, Process Engg. Economics (Chemical Industries) CRC Press 3. Aries & Newton, Chemical Engg. Cost Estimation, McGraw Hill

ECH 751: C.A.D LAB **0 0 3**

Recommended to be done using a commercial simulator

1. Design of a Flow network containing Pumps, fittings and Piping (horizontal, vertical, inclined)
2. Process design of simple reactors (CSTR, Tubular) with or without heat transfer.
3. Process design & Rating of stand alone Multi-component Distillation columns.
4. Process design & Rating of TEMA Type Shell &Tube Heat exchangers.
5. Steady state flow sheeting of acyclic processes.
6. Steady state flow sheeting of Processes with recycles /Purge/Bypass etc.

Recommended to be done using a Simulation Language/Programming Environment

1. Study of dynamic behavior of simple systems such as tank in series, double effect evaporators,etc.
2. Study of coupling of manipulated and controlled variables using relative gain analysis (RTA).

Recommended to be done using a commercial simulator

1. Dynamic simulation of Simple process systems with controllers
2. Dynamic simulation & controllability analysis of Binary distillation column.

Recommended Software

1. Steady state/Dynamic simulator (such as Hysys. Plant or Aspen Plus/Aspen Dynamic)
2. Simulation Language /Programming Environment (MATLAB).

ECH 752: PROJECT **0 0 3**

The student would be allotted a project in the beginning of the VII semester itself. The project will be based on the industry where he/she has undergone in plant training in industry during summer vacations. He/She would be expected to submit a detailed plant design report later in the (VIII) semester.In this semester he/she will be assessed (out of 50 marks) for the work that he/she does during the seventh semester under the supervision of a faculty of the department.

ECH 031: Air pollution and control equipment 3 1 0

Unit I

Air Pollutant Sources, Effects and Clean Air Acts: Pollution of air: Sources and effects of air pollutants on physical environment and living systems, Monitoring of air pollution, Air pollution Laws and national standards [5]

Unit II

Air Pollutant Formation, Dipersion, Analysis: Formation of pollutants through large-scale combustion of fossil fuels, mineral processing, automobiles in urban areas and at source minimisation of release Meteorological aspects of air pollutant dispersion. Chemical reactions in a contaminated atmosphere, urban air pollution, acid rain, Air sampling and measurement, Analysis of air pollutants. [8]

Unit III

Air Pollution Control Methods for Particulates Removal: Control Methods – Source Correction methods Particulate emission control: Dry techniques: Design of industrial dust collectors, gravity settling chambers, cyclone and multiclone separators, fabric & Fibrous filters, electrostatic precipitators, relative merits and demerits, overall selection of gas cleaning equipment, economics. Wet techniques: Design of wet dust collection, wet cyclone, empty scrubber, column (packed) scrubber, ventury scrubber, suitability, merits and demerits, economics. [10]

Unit IV

Control of Specific Gaseous Pollutants: Cleaning of Gaseous effluents - Control of sulphur dioxide emission by various methods - Control of nitrogen oxides in combustion products - Control of release of carbon monoxide and hydrocarbons to the atmosphere; Case studies: Role of APC techniques in coal fired thermal power plants,cement plant and petroleum refinery [10]

Unit V

Noise Pollution and Control: Sound pressure, Power and Intensity - Measures of Noise-Outdoor noise propagation- Indoor Noise propagation- Noise Control [7]

Suggested Books:

1. B.G. Verma, H. Brauer," Air Pollution Control Equipments", Springer, Verlag Berlin, 1981

2. M.N. Rao and H.V.N. Rao, "Air Pollution", Tata McGraw Hill, New Delhi, 1993

3. Rao C .S. "Environmental Pollution Control Engineering," 2nd Edition, New Age International Publishers, 2006

4. A. P. Sincero and G.A. Sincero Environmental Engineering: A Design Approach, Prentice Hall of India Pvt Ltd, N.Delhi, 1996

5. Air Pollution Control Equipment: Selection, Design, Operation and Maintenance, Louis Theodore (Editor), Anthony J. Buonicore (Editor), Springer-Verlag Telos, 1994

ECH 032: INDUSTRIAL POLLUTION ABATEMENT & WASTE MANAGEMENT 3 1 0

Unit I

Introduction: Environment and environmental pollution from chemical process industries, characterization of emission and effluents, environmental Laws and rules, standards for ambient air, noise emission and effluents.[7]

Unit II

Pollution Prevention: Process modification, alternative raw material, recovery of by co-product from industrial emission effluents, recycle and reuse of waste, energy recovery and waste utilization. Material and energy balance for pollution minimization. Water use minimization, Fugitive emission/effluents and leakages and their control-housekeeping and maintenance.[8]

Unit III

Air Pollution Control: Particulate emission control by mechanical separation and electrostatic precipitation, wet gas scrubbing, gaseous emission control by adsorption and adsorption, Design of cyclones, ESP, fabric filters and absorbers. Water Pollution Control: Physical treatment, pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation.[12]

Unit IV

Chemical Treatment: Anaerobic and aerobic treatment biochemical kinetics, trickling filter, activated sludge and lagoons, aeration systems, sludge separation and drying[5]

Unit V

Waste management: Characterization of wastes-hazardous and non-hazardous wastes. Waste disposal and management laws and guidelines. Non-hazardous industrial wastes-treatment, disposal, utilization and management. Value-extraction from the wastes. Handling, storage and

disposal of hazardous wastes. Case studies of a few real scenarios of waste management – sugar, pulp and paper, and fertilizer units [8]

Suggested Books:

1. Pollution Control Acts, Rules and Notifications, CPCB, Delhi. 1995

2. Vallero D., "Fundamentals of Air Pollution", 4th Ed., Academic Press, 2007

3. Eckenfelder W. W., "Industrial Water Pollution Control", 2nd Ed., Mc Graw Hill, 1999

4. Kreith F. and Tchobanoglous G., "Handbook of Solid Waste Management", 2nd Ed., Mc Graw Hill, 2002

5. Pichtel J., "Waste Management Practices: Municipal, Hazardous and Industrial", CRC, 2005

6. Conway R.A. & Ross R.D., "Handbook of Industrial Waste Disposal", Van-Nostrand Reinhold, 1980

7. Tchobanoglous G., Theisen H. & Vigil S.A., "Integrated Solid Waste Management : Engineering Principles and Management Issues", McGraw Hill, 1993

ECH 033: ENVIRONMENTAL POLLUTION MONITORING AND CONTROL 3 1 0

Unit I

Introduction Ecology & Environment, Biodiversity, Interaction of man and environment, Overall picture of Environmental pollution, Ambient air and water quality criteria, Standards and Acts-Indian, EPA& EURO, Effects and control of noise, thermal and radioactive pollution. [8]

Unit II

Air Pollution Types of pollutants – Natural and man made air pollutants, Dispersion of pollutant in the atmosphere, Gaussian dispersion model, Meteorological factors, Stability and inversion of atmosphere, Plume Behaviour, Control of air pollution from stationary and mobile sources, Methods of measuring and sampling of gaseous and particulate pollutants in ambient air and industrial waste gases, measurement of smoke density and visibility .Control of gaseous pollutants-SOx,NOx,H2S,VOCS,Auto exhaust. Stack design, Classification, selection and design of equipment's like cyclones, electrostatic precipitators, bag filters, wet scrubbers, settling chambers. [8]

Unit III

Water Pollution Waste water characteristics – Physical and chemical composition, Biochemical oxygen demand (BOD), Pathogenic bacteria and chemical toxicity. Types of pollutants in waste water of chemical industries,

Methods of sampling, preservation of samples and analysis. Methods for the treatment of liquid wastes to control pollution, Classification viz. physical, chemical and biological methods, Selection and design of equipment like hydrocyclone, settling tanks, filters, ion- exchange. [8]

Unit IV

Solid Wastes Management Characterisation of solid wastes, Problems of collection and handling, Various processing techniques used in solid waste management such as compaction ,incineration, Composting, landfills and biological Processing, Solid waste as resource material. [8]

Unit V

Pollution abatement in important chemical industries like fertiliser, petroleum refineries and etrochemicals, Pulp and Paper, Pharmaceuticals, Tannery, Sugar, Distillery, food processing , cement and electroplating. [8]

Text Books

1. Howard S. Peavy, D. R. Rowe & C. Tchobonoglous "Environmental Engineering", McGraw Hill (1984).

2. Metcalf & Eddy, "Waste Water Engineering Treatment, Disposal & Reuse", Tata McGraw Hill(2003).

Reference Books

1. Werner Strauss, 'Air Pollution Control: Measuring and monitoring air pollutant' Wiley (1978).

2. Werner Strauss, 'Air Pollution Control part -II " Wiley (1978).'

3. Pandey G. N. and Carney G. C., "Environmental Engineering ". Tata McGraw Hill (1991).

ECH 034: HAZARDOUS WASTE MANAGEMENT 3 1 0

Unit1

Characterization: Introduction to Hazardous wastes, Definition of Hazardous waste, The magnitude of the problem. Characterization of industrial wastes-hazardous and non-hazardous wastes. Waste disposal and management laws and guidelines.[8]

Unit2

Non-hazardous Waste Management: Non-hazardous industrial wastes-treatment, disposal, utilization and management. Thermal gasification, combustion and landfill..[8]

Unit3

Hazardous Waste Management: Hazardous wastes – handling, storage. Treatment and disposal methods: Physico-chemical and biological, stabilization and solidification, thermal methods, land disposal, Waste site remediation and clean-up technologies. Wastes from electroplating, lead batteries/cells, soldering and electro winning operations, wastes from refineries and petrochemical units. [8]

Unit4

Risk assessment, Environmental legislation, Dose-response assessment, exposure assement, Waste minimisation and Value-extraction from the wastes. Medical/biomedical and infectious waste management; Transportation of hazardous waste; Ground water contamination, [8]

Unit5

Case Studies:

Case studies of a few real scenarios of hazardous waste management in industries. [8]

Suggested Books:

1. Tedder D. W. & Pohland F. G. (Editors), "Emerging Technologies in Hazardous Waste Management", ACS.1990

2. Conway R. A. & Ross R. D., "Handbook of Industrial Waste Disposal", VanNostrand Reinhold.1980

3. Shah K. L., "Basics of Solid and Hazardous Waste Management Techniques",Prentice Hall.1999

4. Side G. W., "Hazardous Materials and Hazardous Waste Management", John Wiley.1993

5. Pichtel J., "Waste Management Practices: Municipal, Hazardous and Industrial", CRC.2005

ECH 041:PROCESS UTILITIES AND SAFETY IN CHEMICAL PLANTS 3 1 0

Unit I Various process utilities, their role and importance in chemical plants.Water Sources Sources of water and their characteristics ;Treatment storage and distribution of water; water for use in boilers, cooling purposes, drinking and process; Reuse and conservation of water; Water resource management. [8]

Unit II

Steam Generation and Utilization Steam generation and its application in chemical process plants, distribution and utilisation ;Design of efficient steam heating systems; steam economy,

Steam condensers and condensate utilisation Expansion joints ,flash tank design, steam traps their characteristics, selection and application, waste heat utilisation.; Lagging, selection and thickness .Selection and sizing of boilers; waste heat boilers. [8]

Unit III

Compressors, blowers and Vacuum Pumps Compressors, blowers and vacuum pumps and their performance characteristics; Methods of developing vacuum and their limitations, material handling under vacuum, Piping systems; Lubrication and oil removal in compressors and pumps.Air filters,Air and gas leakage. Inert gas systems , compressed air for process, Instrument air. Insulation Importance of insulation for meeting the process requirement, insulation materials and their effect on various material of equipment piping, fitting and valves etc. insulation for high intermediate, low and sub zero temperatures, including cryogenic insulation. [8]

Unit IV

Elements of Safety Elements of safety, safety and site selection; Plant layout and unit plot planning; Definition of risk and hazard, Identification and assessment of the hazards, distinction between hazards and risk, Hazard operability (HAZOP) hazard analysis (HAZAN); Assessment of the risk, fault tree, event tree, scope of risk assessment; Control of hazards, controlling toxic chemicals and controlling flammable materials. Prevention of losses Prevention of losses, Pressure relief, Provision of fire fighting equipments, Technology selection and transfer, Choosing the right process. [8]

Unit V

Control of Process Control of process, Prevention of hazardous deviation in process variables, e.g. pressure, temperature flow by provision of automatic control systems- interlocks, alarms, trips together with good operating practices and management.

Regulations

Regulations and legislation, Role of government role, risk management routines and tackling disaster. [8]

Text Books

1. Nordell, Eskel, “Water Treatment for Industrial and Other Uses”, Reinhold Publishing Corporation, New York.(1961).

2. Crowl, D.A. & Louvar, J.F.. “Chemical Process Safety: Fundamentals with Applications”. New Jersey: Prentice-Hall. (1989).

3. Goodall, P. M., "The Efficient Use Of Steam" IPC Science and Technology (1980).
Reference Books 1. Lees, F. P., "Loss Prevention in Process Industries 3 volume set" Butterwort Heinemann, Oxford (1996).

ECH 042: Corrosion Science and Engineering 3 1 0

Unit I

Basic aspects introduction, classification, economics and cost of corrosion. Emf series, Galvanic series, corrosion theories derivation of potential- current relationship of activation controlled and diffusion corrosion processes. Potential- pH diagrams Fe-H2O system, application and limitations. Passivationdefinition, anodic Passivation, theory of Passivation, oxidation laws, effects of oxygen and alloying on oxidation rates.

Unit II

Forms of corrosion-definition, factors and control methods of various forms of corrosion such as pitting, inter granular, crevice, stress corrosion, corrosion fatigue, hydrogen embrittlement, corrosion processes and control methods in fertilizers, petrochemical and petroleum refineries

Unit III

Environmental aspects: Atmospheric corrosion- classification, factors influencing atmospheric corrosion, temporary corrosion preventive methods, corrosion in immersed condition, effect of dissolved gases, salts, pH, temperature and flow rates on corrosion, Underground corrosion-corrosion process in the soil, factors influencing soil corrosion.

Unit IV

Corrosion control aspects: Electrochemical methods of protection-theory of cathodic protection, design of cathodic protection, sacrificial anodes, anodic protection. Corrosion inhibitors for acidic, neutral and alkaline media, cooling water system-boiler water system. Organic coating-surface preparation, natural synthetic resin, paint formulation and applications. Design aspects in corrosion prevention, corrosion resistant materials.

Unit V

Corrosion Testing, monitoring and inspection, laboratory corrosion tests, accelerated chemical tests for studying different forms of corrosion. Electrochemical methods of corrosion rate measurements by DC and AC methods, corrosions monitoring methods, chemical and electrochemical removal of corrosion products,

Text Book:

1. S.N. Banerjee, An Introduction to Corrosion and Corrosion Inhibition, Oxonian Press Ltd., New Delhi.

Reference Books:

1. LL Shrier Corrosion Vol. I & II George NownonsLtd., Southhampton Street London Endn. II

2. M.G. Fontana & N.D. Greene,Corrosion Engineering, McGraw Hill, New York (3/e)

3. H.H. Uhlig, Corrosion and Corrosion Control. A Wiley- Inter Science. Publication John Wiley & Sons, New York.

4. C.T.Munger- Organic Coatings

5. Jain & Jain, Engineering Chemistry, Dhanpat Rai & Sons, New Delhi

ECH 043: PROJECT ENGINEERING AND MANAGEMENT 3 1 0

Unit I

Role of project engineering in project organisation ;Plant location and plant layout; Start up and shut downs of project; Preliminary data for construction projects; Process engineering; Flow diagram, Plot plans, Scheduling the project; Engineering design and drafting. [8]

Unit II

Business and legal procedures Procurement operations:Organisation and operation of a procurement department, Contract versus Commodity buying; Procurement requiring engineering participation, Procurement of off-the-shelf materials, Expediting and inspection, Procurement procedure, Bid comparisons, The purchase order inspection, Expediting, General purchaser-vendor practices, Project engineering and procurement.Office procedure:Conferences, Technical writing, Filing systems, Contracts and contractors:Engineering and constructors firms, Selecting the contractor, The basis of contract, Type of reimbursement, The contract form, Exhibits, Overtime payments, Typical engineering and construction contracts, Exhibits for engineering and construction contracts, Lump-sump contract form, Contracts and engineers, Ethics and the contract.[8]

Unit III

Details of engineering design and equipment selection: Vessels, Heat exchangers, Process pumps, Compressor and Vacuum pumps, Motors and turbines, Other process equipment, Piping design, Thermal insulation, Process instruments, Plant utilities, Foundations, Structures and buildings, Safety and plant design. [8]

Unit IV

Construction planning: Construction personnel: Jurisdictional disputes and labour relations, Construction labours distribution, Labour rates.Construction operations: Site preparation, Driving of pile, Temporary buildings, Temporary water supply, Road ways and rail road spurs, Excavation operation, Installation of underground facilities, Electrical conduit, Foundation construction, Erection of guyed derrick, Erection of elevated reinforced concrete structures and structural steel, Erection of major equipment, Installation of piping, pipe identification, insulation, Buildings, final stage of construction. [8]

Unit V

Critical path method (cpm): Events and activities; Network diagramming; Earliest start time and earliest finish time ;latest start time and latest finish time; Float, Advantage of CPM ;Cost to finish he projects earlier than normal cost; Precedence diagramming. Programme evaluation and review technique (pert):

PERT network and time estimates; Single versus multiple time estimates; Frequency distribution. [8]

Text Books

Rase F. Howard & Barrows M. H.," Project engineering of process plant"Wiley (1957)

Reference books

1. Peter S. Max & Timmerhaus, Plant design and economics for chemical engineers. Mc Graw Hill (2002).

2. Srinath L. S., "PERT AND CPM." affiliated east press pvt. Ltd., new york (1973)

3. Perry J. H.,"Chemical engineering handbook" 7TH ed. Mc Graw Hill (1997).

4. JELLEN F. C., "Cost and optimization in engineering". Mc Graw Hill (1983

SUBJECT CODE: ECH 044 COURSE TITLE:ISHM

COURSE OUTCOME:

On completion of this course, the students will be able to

1. Understand Industrial safety and hygiene and explain safety aspects related to toxicity, noise, pressure, temperature, radiation, vibration etc. and to explain explosions in industries.
2. Analyse the aspects of safety in chemical plant and to understand identification and assessment of hazards and risks.
3. Evaluate the toxicity, its effects in chemical plants and understand techniques and methods to prevent exposure to toxic substances.

4. Explain relief system and release of hazardous material due to leakage.
5. Understand the handling and transportation methods for toxic and flammable substances and understand the need and methods for disaster planning.

Syllabus

Unit I

Industrial safety, Industrial hygiene and safety aspects related to toxicity, noise, pressure, temperature, vibrations, radiation etc. Explosions including dust , vapor, cloud and mist explosion.
[06]

Unit II

Elements of safety, safety aspects related to site, plant layout, process development and design stages, identification of hazards and its estimation, risk, risk analysis and assessment methods; fault free method, event free method, scope of risk assessment, controlling toxic chemicals and flammable materials. [10]

Unit III

Toxic substances and degree of toxicity, its estimation, their entry routes into human system, their doses and responses, control techniques for toxic substances exposure, use of respirators, ventilation systems [08]

Unit IV

Prevention of losses, pressure relief, provision for fire fighting, release of hazardous materials from tanks, pipes through holes and cracks , relief systems : types and location of reliefs. [08]

Unit V

Handling, transportation and storage of of flammable liquids, gases, and toxic materials and wastes, regulation and legislation, government role, risk management routines, emergency preparedness, disaster planning and management. [08]

Books Recommended

1. D. A. Crowl and J.F. Louvar – Chemical Process Safety (Fundamentals with Applications), Prentice Hall (1990)
2. H.H. Fawcett and W.S. Wood – Safety and Accident prevention in Chemical Operations, 2nd Edition, John Wiley &Sons,New York, 1982.
3. Coulson & Richardson's Chemical Engineering – Vol. 6 – R.K. Sinnott, Butterworth – Heinmann Ltd., 1996.
4. Sanjoy Banerjee, Industrial Hazards & Plant Safety, Taylor & Francis Group

ECH 801: TRANSPORT PHENOMENA 3 1 0

COURSE OUTCOME:

1. Apply the fundamental knowledge of science and engineering to formulate analogies between heat, momentum and mass transfer processes.
2. explain shell balance approach for stress distribution and velocities profiles along with appropriate boundary conditions for momentum transfer processes.

3. Analyze the outcomes of mathematical solution related to various unsteady state momentum transport processes.

4. Formulate the differential forms of the equations of change for heat transfer problems for steady and unsteady state systems

5. Formulate the differential forms of the equations of change for heat transfer problems for steady and unsteady state systems

Syllabus

Unit I

Introduction to Transport Phenomena Similarity between momentum, heat and mass transfer, The continuum hypothesis, Basic laws of fluid motion, Newton's second law of motion, principle of balance between momentum, heat and mass transfer, Principles of conservation of momentum, mass and energy.

Unit II

Momentum Transport Phenomena Momentum transport in laminar flow: Newton's law of viscosity, Science of rheology, Prediction of viscosity and its dependence on temperature, pressure and composition, Boundary condition

ns, Shell balance approach for stress distribution and velocity profiles. Introduction to time derivatives and vector analysis, Equation of continuity and equation of motion and their applications in fluid flow problems.

Unit III

Unsteady state momentum transport, Flow near a wall suddenly set in motion, Momentum transport phenomena in turbulent flow. Definitions of friction factors, friction factor for flow in tubes, for flow around spheres, for packed bed column.

Unit IV

Energy Transport Phenomena Energy transport in laminar flow: Fourier's law of heat conduction, Prediction of thermal conductivities and its dependence on temperature, pressure and composition, Boundary conditions, shell balance approach. Types of heat sources, Principle of extended surfaces, types of cooling fans, free and forced convection. Unsteady state heat

transport, Unsteady state heat conduction in solids, heating of semiinfinite slab, heating of finite slab.

Unit V

Mass Transport Phenomena Definitions of concentration, velocities and mass fluxes, Fick's law of diffusion, Prediction of diffusivity and its dependence on temperature, pressure and composition, Boundary conditions, Shell balance approach for mass transfer problems, Problems of diffusion with homogeneous and heterogeneous chemical reaction, Diffusion and chemical reaction in porous catalyst – the effectiveness factor. The equation of continuity for multicomponent mixtures.

Text Books

1. Bird, R. B., Stewart, W. E. and Lightfoot, E. N., "Transport Phenomena", 2nd edition John Wiley (1960).

2. Bannet, C. O. and Myers J. E., "Momentum Heat and Mass Transfer" Tata McGraw Hill, (1973)..

3. RS Broadkey dan HC Hersey, "Transport Phenomena:AUnified approach", McGraw-Hill Book, (1988).

Reference Books

1. Beck, W. J. and Muttzall, K.M.K., "Transport Phenomena", John Wiley, (1975).

2. Loddha, G. S. and Degaleesan T. E. "Transport Phenomena in Liquid Extraction", Tata McGraw Hill, (1975).

3. Slattery, J. "Momentum, Energy and Mass Transfer in Continua", McGraw Hill, (1972).

4. Scissom, L. E. and Pitts, D. R., "Elements of Transport Phenomena", McGraw Hill, (1972).

5. Theodere, L. "Transport Phenomena for Engineers", International Textbook Co. (1971).

ECH 851: PROJECT **0 0 12**

This project course is in continuation of project course (ECH 752) allotted in the beginning of the VII the semester .Here the students are supposed to do the detail work as scheduled in the last semester. Finally he/she will be required to submit a detailed project report on which viva-voce examination will be conducted by a committee having one External Examiner.

ECH 061: FERTILIZER TECHNOLOGY **3 1 0**

Syllabus

Unit I

Introduction of Indian fertilizer industries, types of fertilizers process details. [8]

Unit II

Manufacture of Nitrogeneous, Phosphatic, potassic, complex, NPK, mixed, Dio and other fertilizers. [8]

Unit III

Discussion of existing Indian plants pollution and its control, abetment and disposal of waste of fertilizer units. [8]

UnitIV

Retrofits and modernization, computer control and Instrumentation, Energy conservation and diversification. [8]

UnitV

Design of Ammonia converters and other reactors, cooling water, expansion, capacity utilization and other problem of fertilizers industry. [8]

Books:

1. Mortvedt J.J.,Murphy L.S.& Follett R.H., Fertilizer Technology & Application, Meister Publishing Company
2. Shreves Chemical Process Industries, McGraw Hill
3. Drydens Outlines of Chemical Technology, East West Press

SUBJECT CODE: ECH 062 COURSE TITLE: PETROLEUM REFINING AND TECHNOLOGY

COURSE OUTCOME:
On completion of this course, the students will be able to

1. Explain the process of exploration and production of crude and understand the chemistry and classification of different types of crude.
2. Understand the need of quality control of petroleum products and various laboratory test used for testing quality of petroleum products for a particular application.
3. Understand various catalytic conversion and finishing processes.

4. Understand Lube oil, petroleum wax and bitumens manufacturing process.

Syllabus

Unit I

Petroleum Exploration Production and Refining of Crude oils Crude oils: Chemistry and composition (Characteristics and constituents of crude oils, Classification of crude oils). [8]

Unit II

Quality Control of Petroleum Products Classification of laboratory tests, distillation, vapour pressure, flash and fire points, octane number, performance number, cetane number, aniline point, viscosity index, calorific value, smoke point, char value, viscosity, viscosity index, penetration tests, cloud and pour points, drop point of grease, melting and settling points of wax, softening point of Bitumen, induction period of gasoline, thermal stability of jet fuels, gum content, Total Sulphur, Acidity and Alkalinity,, Copper Strip Corrosion Test, Silver – Strip Corrosion Test for ATF, Ash, Carbon Residue (Conradson method, Ramsbottom method) Colour, Density and Specific gravity, Refractive index of hydrocarbon liquids, water separation index (modified) (WSIM), ductility. [8]

Unit III

Petroleum Products Composition, Properties & Specification of LPG, Naphthas, motor spirit, Kerosine, Aviation Turbine Fuels, Diesel Fuels, Fuel Oils, Petroleum Hydrocarbon Solvents, Lubricating oils (automotive engine oils, industrial lubricating oils electrical insulating oils, Jute Batching oils, white oils, steam turbine oils, metal working oils, etc.) Petroleum Waxes Bitumens, Petroleum coke. Crude Oil Distillation Desalting of crude oils, Atmospheric distillation of crude oil, Vacuum distillation of atmospheric residue. Thermal Conversion Process Thermal Cracking Reactions, Thermal Cracking, Visbreaking, (Conventional Visbreaking and Soaker Visbreaking) Coking (Delayed Coking, Fluid Coking, Flexicoking), Calcination of Green Coke. [8]

Unit IV

Catalytic Converson Process Fluid catalytic cracking; Catalytic reforming; Hydrocracking Catalytic Alkylation, Catalytic Isomerization; Catalytic Polymerization.
Finishing Process Hydrogen sulphide removal processes; Sulphur conversion processes; Sweetening processes (Caustic treatment, Solutizer process; Doctor treating process; Copper chloride sweetening,; Hypochlorite sweetening ;Air and inhibitor treating process; Meroxprocesses;Sulphuric acid treatment; Clay treatment); Solvent extraction processes (Edeleanu process, Udex process, Sulfolane process), Hydrotreating processes. [8]

Unit V

Lube Oil Manufacturing Process Evaluation of crude oils for lube oil base stocks, Vacuum distillation, Solvent deasphalting Solvent extraction of lube oil fractions (Furfural, NMP and Phenol),Solvent dewaxing, Hydrofinshing, Manufacture of petroleum waxes (Wax sweating,

Solvent deoiling) Manufacture of Bitumens Selection of crude oil, Methods of manufacture of bitumens, (Distillation, Solvent precipitation, Air blowing). [8]

Books Recommended

1. Nelson, W.L., Petroleum Refining Engineering, McGraw Hill
2. Mall, I D ,Petrochemical Process Technology, McMillan India
3. Sarkar,G.N., Advance Petroleum Refining, Oscar Publication

ECH 063: PETROCHEMICAL TECHNOLOGY

Syllabus

Unit-I

Production and consumption pattern of petrochemicals in India, Feedstocks for petrochemicals-Natural gas, LPG, Refinery off-gases, Hydroforming of petroleum stocks, Naphtha and fuel oils, Petroleum coke

Unit-II

Steam reforming and partial oxidation processes for syngas, Manufacture of Methanol, Formaldehyde, Chloromethanes, Trichloroethylene, Perchloroethylene, Acetic acid, adipic acid

Unit-III

Ethylene and acetylene via steam cracking of hydrocarbons, Manufacture of Ethylene dichloride, Vinyl chloride, Ethylene oxide, Ethanolamines, Acetaldehyde, Vinyl acetate, Ethyl acetate, Ethylene glycol

Unit-IV

Manufacture of Isopropanol, Acetone, Methyl ethyl ketone, Methyl isobutyl ketone, Cumene, Acrylonitrile, Propylene oxide, Butadiene, Oxo process

Unit-V

Manufacture of Benzene, Toluene, Xylenes, Phenol, Styrene, Phthalic anhydride, Maleic anhydride, Nitrobenzene, Aniline, Bisphenol-A, Caprolactum

Books Recommended

1. Mall, I D ,Petrochemical Process Technology, McMillan India

2. Bhaskar Rao, Modern Petroleum Refining Processes, Oxford & IBH Publishing

3. Speight J., Chemistry & Technology of Petroleum, Marcel Dekker Inc.

4. Robert Mayer,Handbook of Petroleum Refining Processing, McGraw Hill

ECH 051: ADVANCED SEPARATION TECHNOLOGY 3 1 0

Syllabus

Unit I

Uses and characterization of separation processes, equilibrium and rate governed multistage processes. [8]

Unit II

ideal cascades total interstage flows, squared off cascades, seperative duty and potential, energy requirement for separation processes. [8]

Unit III

30 Membrane characterization, Gas permeation through polymeric membranes, Liquid membrane separation processes, reverse osmosis , Concentration polarization. [8]

Unit IV

Dialysis, Ultra filtration, Electro dialysis. [8]

Unit V

Chromatographic separation, molecular sieve separations. [8]

Books Recommended

1. Geankoplis, C.J.. "Transport Processes and Unit Operations", 3rd ed. Prentice Hall. (1993)

2. Sun-Tak-Hwang and Karl Kammermeyer – Membranes in Separations – John Wiley & Sons, New York (1975)

3. J.M. Coulson and J.F. Richardson – Chemical Engineering: Particle Technology and Separation Processes, Vol. 2, 4 th Edition, Asian Books Pvt. Ltd. New Delhi (1998)

4. Christie J. Geankoplis – Transport Processes and Unit Operations – 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi

5. King C.J., Separation Processes, Tata McGraw Hill

ECH 052: DESIGN OF PIPING SYSTEMS 3 1 0

Unit 1

Analysis of pipe flow Energy losses in pipe lines, concept of equivalent length and equivalent pipes, problems in pipe flow, hydraulic power transmission through a pipe line. [8]

Unit 1I

Negative pressure in pipe lines, Siphon, Multiple pipe systems, working pressure, designpressure, choice of pipe materials, hydraulic analysis of complex pipe networks. [8]

Unit 1II

Aids in selecting pipe valves and fittings, standards for piping design, Dimensional and mechanical standards for pipe valves and fittings. [8]

Unit 1V

Process piping arrangement plant layout and equipment arrangement, criteria for equipment layout, piping layout and arrangement. [8]

Unit V

Pipe fabrication, vibration, its prevention and control in piping systems. [8]

Books Recommended

1. King, R. C. and Croker, S., "Piping Handbook", McGraw Hill.

2. Kellogg, M. W Company., "Design of Piping Systems", Pullman Power Products, New York (1976).

ECH 053: FLUIDIZATION ENGINEERING 3 1 0

Syllabus

UnitI

Introduction: Importance of fluidization in process industry, comparison of fluidized beds with other modes of contacting, advantages and disadvantages, industrial applications. Fluidization: Fixed bed of particles of one and mixed sizes, fluidization with and without carryover of particles, minimum fluidization, terminal velocity of particles, pneumatic transport of solids,[10]

UnitII

Bubble Behavior and Bed Properties: Single rising bubble models, wake region and solids within bubbles, interaction and coalescence of bubbles, bubble formation, slug flow.[8]

Unit III

Bubbling Fluidized Beds: Emulsion phase, gas flow, bubble properties, physical and flow models. Entrainment and Elutriation From Fluidized Beds: Free boards behavior, gas outlet location, entertainment from tall and short vessels.[8]

UnitIV

High Velocity Fluidization: Turbulent fluidized beds, fast fluidization, pressure drop in turbulent and fast fluidization. Spouted Beds: Hydrodynamics and processing in spouted beds.[6]

UnitV

Circulation Systems: Circuits for the circulation of solids, pressure balance, flow of gas-solid mixtures in down-comers, flow in pneumatic transport lines. Design for Physical Operations: Design of single stage and multistage systems, heat and mass transfer, fluid bed drier.[8]

Books:

1. Kunii D. and Levenspiel O., "Fluidization Engineering", 2nd Ed., Butterworth-Heinemann,1991.

2. Davidson D. and Harrison J. F., "Fluidization Engineering", 2nd Ed., Academic Press,1992.
3. Yang W. C., "Handbook of Fluidization and Fluid Particle Systems", 3rd Ed.

ECH 054: MULTIPHASE REACTOR DESIGN 3 1 0

Syllabus

Unit I

Basic data and principles for design, Interpretion of data from laboratory. [8]

Unit II

Batch, C.S.T.R. and Tubular flow reactors, Accuracy of Kinetic Measurements, Thermodynamic aspect of chemical reactions. [8]

Unit III

Summary of catalyst preparation methods, Catalyst characterization. [8]

Unit IV

Establishing global rate of reaction, Mass & Energy balance equation for reactors. [8]

Unit V

Reactor design using Global rates and actual temperature and connection profile

Books:

1.Peter Harroitt , Chemical Reactor Design, McGraw Hill

2.Trehan M., Catalytic Reactor Design, McGraw Hill

3.Hayes R.E., Chemical Reactor Analysis, Gordon & Breach Science Publisher

4.Cooper A.P.& G.V.Jefferys, Chemical Kinetics & Reactor Design, Prentice Hall

5. Gianetta & Silvertan, Multiphase Chemical Reactor- Theory, Design, Scale up, Hemisphere Publishing Corp.