Department of Chemical Engineering

Syllabi for:

B.Tech Chemical Engineering

Effective from 2012-2013

Indian School of Mines
Dhanbad- 826 004
Jharkhand, India

COURSE STRUCTURE FOR CHEMICAL ENGINEERING

I SEMESTER B. TECH - PHYSICS (GROUP - I)

Course No.	Name of the Courses	L	T	P	Credit Hours
AMC 11101	Mathematics-I	3	1	0	7
APC 11101	Physics	3	0	0	6
MMC 11101	Engineering Graphics	1	4	0	6
EEC 11101	Electrical Technology	3	1	0	7
MMC 11103	Engineering Mechanics	3	1	0	7
GLD/CMD 11301	Earth System Science (S) [AGL 2-0-0 & ESE 1-0-0]	3	0	0	6
HSC 12305	Value Education, Human Rights and Legislative Procedure (S)	3	0	0	6
APC 12201	Physics Practical	0	0	3/2	1.5
EE 12201	Electrical Technology Practical	0	0	3/2	1.5
Total		19	7	3	48
Contact Hrs.					29

I SEMESTER B. TECH - CHEMISTRY (GROUP - II)

Course No.	Name of the Courses	L	T	P	Credit Hours
AMC 11101	Mathematics-I	3	1	0	7
ACC 11101	Chemistry	3	0	0	7
MMC 11102	Manufacturing Process	1	4	0	6
ECE 11101	Electronics Engineering	3	0	0	6
CSE 11301	Computer Programming (S)	3	0	0	6
DMS/AP 11301	Disaster Management [DMS 2-0-0] & Energy Resources [AP 1-0-0] (S)	3	0	0	6
HSC 11103	English for Science & Technology	3	0	0	6
ACC 12201	Chemistry Practical	0	0	3/2	1.5
ECE 11201	Electronics Engineering Practical	0	0	3/2	1.5
CSE 12301	Computer Programming Practical (S)	0	0	2	2
Total		19	5	5	48
Contact Hrs.					29

II SEMESTER B. TECH - CHEMISTRY (GROUP - I)

Course No.	Name of the Courses	L	T	P	Credit Hours
AMC 12101	Mathematics-II	3	1	0	7
APC 11101	Physics	3	0	0	6
MMC 11101	Engineering Graphics	1	4	0	6
EEC 11101	Electrical Technology	3	1	0	7
MMC 11103	Engineering Mechanics	3	1	0	7
GLD/CMD 11301	Earth System Science (S) [AGL 2-0-0 & ESE 1-0-0]	3	0	0	6
HSC 12305	Value Education, Human Rights and Legislative Procedure (S)	3	0	0	6
SWC 12701	Co-Curricular Activities (Only for Second Semester)	0	0	0	(3)
APC 12201	Physics Practical	0	0	3/2	1.5
EE 12201	Electrical Technology Practical	0	0	3/2	1.5
Total		**19**	**7**	**3**	**48 + (3)**
Contact Hrs.					**29**

II SEMESTER B. TECH - PHYSICS (GROUP - II)

Course No.	Name of the Courses	L	T	P	Credit Hours
AMC 12101	Mathematics-II	3	1	0	7
ACC 11101	Chemistry	3	0	0	7
MMC 11102	Manufacturing Process	1	4	0	6
ECE 12101	Electronics Engineering	3	0	0	6
CSE 11301	Computer Programming (S)	3	0	0	6
DMS/AP 11301	Disaster Management [DMS 2-0-0] & Energy Resources [AP 1-0-0] (S)	3	0	0	6
HSC 11103	English for Science & Technology	3	0	0	6
SWC 12701	Co-Curricular Activities (Only for Second Semester)	0	0	0	(3)
APC 12201	Chemistry Practical	0	0	3/2	1.5
ECE 12201	Electronics Engineering Practical	0	0	3/2	1.5
CSE 12301	Computer Programming Practical (S)	0	0	2	2
Total		**19**	**5**	**5**	**48 + (3)**
Contact Hrs.					**29**

COURSE STRUCTURE FOR CHEMICAL ENGINEERING
Second Year-Third Semester

SI No	Course No.	Paper	L- T- P	Total Cr. Hr.
		Theory & Tutorial		
1.	CHC13101	Fluid Mechanics	3 – 1 – 0	7
2.	CHC13102	Chemical Process Calculations	3 – 1 – 0	7
3.	ACR 13101	Chemistry for Chemical Engineers	3 – 0 – 0	6
4.	MMR13101	Mechanical Engineering-I	3 – 1 – 0	7
5.	AMR13101	Methods of Applied Mathematics-I	3 – 1 – 0	7
6.	HSC HSE-13302 HSE-13303 HSE-13304 HSE-13305 HSE-13306 HSE13307 HSS351 / HSS13301	Humanities and Social Sciences Optional papers (Sessional) Any one of the following Philosophy of Science Gandhian Studies Oral Communication Skills Oral Presentation Skills Literary Communication Present History Of India History of Science and Technology	3– 0 – 0	6
		Practical & Other		
7.	CHC13206	Fluid Mechanics Lab	0 – 0 – 3	3
8.	CHC13207	Instrumental Methods of Analysis	0 – 0 – 3	3
9.	CHC13208	Project Work	0 – 0 – 2	2
		Total	18 –4 - 8	48

COURSE STRUCTURE FOR CHEMICAL ENGINEERING
Second Year-Fourth Semester

SI No	Course No.	Paper	L- T- P	Total Cr. Hr.
		Theory & Tutorial		
1.	CHC14101	Heat Transfer	3 – 1 – 0	7
2.	CHC14102	Chemical Engineering Thermodynamics-I	3 – 1 – 0	7
3.	CHC14103	Mechanical Operations	3 – 1 – 0	7
4.	ACR14101	Material Science and Technology	3 – 0 – 0	6
5.	AMR14101	Numerical and Statistical Methods	3 – 1 – 0	7
6.	HSC14306	English for Professional Communications (Sessional)	3 – 0 – 0	6
		Practical & Other		
7.	CHC14201	Heat Transfer Lab	0 – 0 – 2	2
8.	CHC14202	Mechanical Operation Lab	0 – 0 – 2	2
9.	CHC14209	Comprehensive Viva-Voce	0 – 0 – 0	(4)
10.	SWC14701	Co-Curricular Activity	0 – 0 – 0	(3)
11.	CHC14210	Project Work	0 – 0 – 2	2
		Total	18 –4 - 6	46+(7) =53

COURSE SRTUCTURE FOR CHEMICAL ENGINEERING
Third Year-Fifth Semester

SI No	Course No.	Paper	L- T- P	Total Cr. Hr.
		Theory & Tutorial		
1.	CHC15101	Chemical Reaction Engineering - I	3 – 1 – 0	7
2.	CHC15102	Chemical Engineering Thermodynamics – II	3 – 1 – 0	7
3.	CHC15103	Energy Resources and Utilization	3 – 0 – 0	6
4.	CHC15104	Mass Transfer-I	3 – 1 – 0	7
5.	CSR13101	Data Structures	3 – 0 – 0	6
6.	CHC15105	Elements of Biochemical Processes – Sessional	3 – 0 – 0	6
		Practical & Other		
7.	CHC15201	Chemical Reaction Engineering Lab	0 – 0 – 3	3
8.	CHC15202	Fuel Analysis Lab	0 – 0 – 2	2
9.	CHC15208	Plant Visits/Excursions	0 – 0 – 0	(2)
10.	CHC15209	Project Work	0 – 0 – 4	4
		Total	18 –3–9	48+(2) =50

COURSE STRUCTURE FOR CHEMICAL ENGINEERING

Third Year - Sixth Semester

Sl No	Course No.	Paper	L- T- P	Total Cr. Hr.
		Theory & Tutorial		
1.	CHC16101	Chemical Reaction Engineering II	3 – 1 – 0	7
2.	CHC16102	Chemical Process Technology	3 – 0 – 0	6
3.	CHC16103	Process Equipment & Piping Design	3 – 1 – 0	7
4.	CHC16104	Mass Transfer - II	3 – 1 – 0	7
5.	CHC16105	Process Control and Instrumentation	3 – 0 – 0	6
6.	MSR14151	Managerial Economics (Sessional)	3 – 0 – 0	6
		Practical & Other		
7.	CHC16204	Mass Transfer Lab	0 – 0 – 3	3
8.	CHC16205	Process Control & Instrumentation Lab	0 – 0 – 2	2
9.	CHC16209	Project & Seminar	0 – 0 – 4	4
10.	CHC16210	Comprehensive Viva-Voce	0 – 0 – 0	(3)
		Total	18 – 3–9	48+ (3) = 51

COURSE SRTUCTURE FOR CHEMICAL ENGINEERING
Fourth Year – Seventh Semester

SI No	Course No.	Paper	L- T- P	Total Cr. Hr.
Theory & Tutorial				
1.	CHC17101	Chemical Process Plant Design and Economics	3 – 1 – 0	7
2.	CHC17102	Transport Phenomena	3 – 1 – 0	7
3.	CHC17103	Process Utilities and Energy Management	3 – 1 – 0	7
4.	CHC17104	Modeling and Simulation	3 – 1 – 0	7
5.		Elective- I – Any One	3 – 0 – 0	6
	CHE17105	a.Fluidization Engineering		
	CHE17106	b.Polymer Science and Technology		
	CHE17107	c.Multi-Component Separation		
	AC/CHE17108	d.Corrosion Engineering		
	MSC17152	e.Industrial Engineering & Management		
Practical & Other				
6.	CHC 17201	Process Simulation Lab	0 – 0 – 3	3
7.	CHC17211	Projects	0 – 0 – 6	6
8.	CHC17212	Vocational Training	0 – 0 – 0	(5)
		Total	15 –4 –9	43+(5) =48

COURSE SRTUCTURE FOR CHEMICAL ENGINEERING
Fourth Year –Eighth Semester

SI No	Course No.	Paper	L- T- P	Total Cr. Hr.
center: **Theory & Tutorial**				
1.	CHC18101	Safety and Hazard Analysis in Process Industries	3 – 1 – 0	7
2.	ESE18101	Industrial Pollution control & Management	3 – 1 – 0	7
3.	CHC18102	Petroleum Refining and Petrochemicals	3 – 1 – 0	7
4.		Elective-II (Any One)	3 – 1 – 0	7
	CHE18103	a.Computer aided process equipment design		
	CHE18104	b.Advanced Separation Technology		
	CHE18105	c.Advance Process Dynamics and Control		
	PEC16103	d.Natural Gas Engineering		
	CHE18106	e.Optimization Techniques		
5.		Elective-III (Any One)	3 – 0 – 0	6
	CHE18107	a.Clean Coal Technology		
	CHE18108	b.Applied Catalysis		
	CHE18109	c.Particulate Science and Technology		
	CHE18110	d.Interfacial Science and Technology		
	CHE18111	e.Green Technologies		
center: **Practical & Other**				
6.	CHC18210	Project	0 – 0 – 6	6
7.	CHC18212	Comprehensive Viva-Voce	0 – 0 – 0	(4)
8.	CHC18213	Excursions	0 – 0 – 0	(2)
		Total	15 – 4–6	40+ (6) =46

CORE COURSE SYLLABI OF I & II SEMESTER

AMC 11101   **MATHEMATICS- I**   **[3–1–0]**

Calculus-I: Successive differentiation of one variable and Leibnitz theorem, Taylor's and Maclaurin's expansion of functions of single variable, Functions of several variables, partial derivatives, Euler's theorem, derivatives of composite and implicit functions, total derivatives, Jacobian's, Taylor's and Maclaurin's expansion of functions of several variables, Maxima and minima of functions of several variables, Lagrange's method of undetermined multipliers, Curvature and asymptotes, concavity, convexity and point of inflection, Curve tracing.

Calculus-II: Improper integrals, convergence of improper integrals, test of convergence, Beta and Gamma functions and its properties, Differentiation under integral sign, differentiation of integrals with constant and variable limits, Leibnitz rule.

Evaluation of double integrals, Change of order of integrations, change of coordinates, evaluation of area using double integrals, Evaluation of triple integrals, change of coordinates, evaluation of volumes of solids and curved surfaces using double and triple integrals. Mass, center of gravity, moment of inertia and product of inertia of two and three-dimensional bodies and principal axes.

Trigonometry of Complex Number, 3D Geometry and Algebra: Function of complex arguments, Hyperbolic functions and summation of trigonometrical series.

3D Geometry: Cones, cylinders and conicoids, Central conicoids, normals and conjugate diameters.

Algebra: Convergency and divergency of Infinite series. Comparison test, D' Alembert's Ratio test, Raabe's test, logarithmic test, Cauchy's root test, Alternating series, Leibinitz test, absolute and conditional convergence, power series, uniform convergence.

AMC 12101   **MATHEMATICS- II**   **[3–1–0]**

Vector Calculus and Fourier series:

Vector Calculus: Scalar and vector fields, Level surfaces, differentiation of vectors, Directional derivatives, gradient, divergence and curl and their physical meaning, vector operators and expansion formulae, Line, surface and volume integrations, Theorems of Green, Stokes and Gauss, Application of vector calculus in engineering problems, orthogonal curvilinear coordinates, expressions of gradient, divergence and curl in curvilinear coordinates.

Fourier Series: Periodic functions, Euler's formulae, Dirichlet's conditions, expansion of even and odd functions, half range Fourier series, Perseval's formula, complex form of Fourier series.

Matrix Theory: Orthogonal, Hermitian, skew- Hermitian and unitary matrices, Elementary row and column transformations, rank and consistency conditions and solution of simultaneous equations, linear dependence and consistency conditions and solution of simultaneous equations, linear dependence and independence of vectors, Linear and orthogonal transformations, Eigen values and Eigen vectors, properties of Eigen values, Cayley-Hamilton theorem, reduction to normal forms, quadratic forms, reduction of quadratic forms to canonical forms, index, signature, Matrix calculus & its applications in solving differential equations.

Differential Equations: Differential Equations of first order and higher degree, Linear independence and dependence of functions. Higher order differential equations with constant coefficient, Rules of finding C.F. and P.I., Method of variation of parameter Cauchy and Legendre's linear equations, Simultaneous linear equations with constant coefficients, Linear differential equations of second order with variable coefficients; Removal of first derivative (Normal form), Change of independent variable, Applications of higher order differential equations in solution of engineering problems.

Partial Differential equations: Formation of P.D.E, Equations solvable by direct integration, Linear and non-linear equations of first order, Lagrange's equations, and Charpit's method, Homogeneous and non-homogeneous linear P.D.E. with constant coefficients, Rules for finding C.F. & P.I.

Recommended books for Mathematics I & II:
1. Higher Engineering Mathematics by B.V. Ramana, Tata McGraw-Hill.
2. Advanced Engineering Mathematics by R.K. Jain and S.R.K. Iyengar, Narosa Publishing House.
3. Calculus and Analytic Geometry by G.B. Thomas and R.L. Finney, Narosa Publishing House.
4. Advanced Engineering Mathematics by M.D. Greenberg, Pearson.
5. Higher Engineering Mathematics by B.S. Grewal, Khanna Publishers.

APC11101/APC12101   PHYSICS   [3-0-0]

Thermal Physics: Concepts of distribution of molecular velocities; Distribution laws and statistics MB, FD and BE, mean free path; Transport phenomena-viscosity, diffusion; thermal conductivity, measurement of thermal conductivity; periodic and aperiodic flow of heat; Wiedemann-Franz law. Heat radiation; black body and black body radiation; Planck's distribution law and its application to classical distribution (Rayleigh-Jeans and Wiens) and total radiation (Stefan-Boltzmann) laws.

Modern Physics: Brief idea of molecular spectra; Rigid rotator, spectra of simple molecules, rotation and rotation-vibration spectra. Brief idea of wave pocket and wave function, Schrödinger equation, Particle in a Box. Free electron theory; qualitative idea of band theory of solids and Hall effect, Laser and laser systems (He-Ne and Ruby Lasers).

Electromagnetics and Electrical Phenomena in Rocks: Maxwell's field

equation, Equation of electromagnetic field, Propagation of electromagnetic waves in different isotropic media, energy of electromagnetic waves, Poynting's theorem & Poynting's vector. Rocks and minerals as dielectrics, electrical conductivity and electrical phenomena in rocks, Piezo-, ferro-, tribo-, and pyro-electricity.

Recommended Books:

1. Heat And Thermodynamics; Brij Lal & Subrahmanyam; S Chand & Co Ltd; 2001

2. Thermal And Statistical Physics; R B Singh; New Age Publications; 2009

3. An Introduction To Thermal Physics; Schroeder; Dorling Kindersley India; 2007

4. Thermal Physics And Statistical Mechanics; Roy & Gupta; New Age Publications; 2001

5. Concepts Of Modern Physics; Beiser; McGraw-Hill Science; 2010

6. Modern Physics; Sivaprasath & Murugeshan; S. Chand Publisher; 2009

APC11201/APC12201   PHYSICS PRACTICAL   [0-0-3/2]

Measurement of thermal conductivity of bad conductors, Optical   experiments on Diffraction using   diffraction   grating, Experiments on Semi-conductors Measurement of band gap and Hall Effect,

experiments using He-Ne Laser - Diffraction Experiments to measure diameter of circular aperture, Polarisation Experiments to measure Brewster's angle & refractive index.

ACC11101 / ACC11102   CHEMISTRY   [3-0-0]

Cement: Manufacturing, composition, setting and hardening of cement.

Glass : Types of Glasses, Manufacturing & properties of Glasses.

Polymer : Classification, structure-property relationship, conductive polymers.

Solid Fuel : Structure of coal, classification of coal, Effect of heat on coal, carbonization and pyrolysis. Recovery and purification of byproducts obtained from coke ovens; Distillation of coal tar; coal.

Liquid fuel: Composition of crude oil, processing of crude oil, distillation, sweetening and cracking (basic concepts), octane number, Cetane number. Additives to improve the quality of diesel and petrol, bio-diesel.

Gaseous fuel: Characteristics of good fuel; calorific value, theoretical calculations of calorific value of a fuel, natural gas and hydrogen gas.

Phase rule & Phase equilibrium: Phase rule; degree of freedom, one and two component systems, temperature and composition diagrams, liquid-liquid and liquid-solid phase diagrams.

Lubricants: General characteristics of lubricants, chemistry of lube oil and greases. Reclamation of lubricants.

Equilibrium: Electrochemistry; Electric potentials at interfaces, electrodes, batteries. electrochemical cells and their applications.

Corrosion: Chemical and electrochemical corrosion, classification, factors affecting corrosion, Form of corrosion and general methods of corrosion prevention.

ACC12101 / ACC12102   CHEMISTRY PRACTICAL   [0-0-3/2]

1. Standards of HCl by Standard Sodium Carbonate solution.

2. Determination of Temporary Hardness of tap water.

3. Estimation of Total Hardness of water.

4. Determination of Iron in Ferrous Ammonium Sulphate solution (Redox titration).

5. Determination of Copper in crystallized Copper-Sulphate.

6. Estimation of available Chlorine in Bleaching Powder.

7. Determination of Molecular Weight of Organic Acid by Titration method.

8. Estimation of Sodium Carbonate and bicarbonate in a mixture.

9. To determine the saponification number of an oil.

10. To determine the rate of hydrolysis of methyl /ethyl acetate.

11. To prepare Chrome Alum.

Recommended Books:

1. A Textbook of Engineering Chemistry-Sashi Chawla

2. Applied Chemistry: A Textbook for Engineers and Technologists - H.D.Gesser.

3. Engineering Chemistry - P.C.Jain & Monika Jain

4. Engineering Materials - K.G. Budinski

MMC 11101/ MMC 12101   ENGINEERING GRAPHICS   [1–4–0]

Introduction: Drawing instruments and their uses; Indian standards for drawing. Lettering and Types of lines used in engineering graphics.

Curves used in engineering practice: Conic sections, ellipse, parabola, hyperbola, cycloid, epicycloid, hypocycloid, involutes and spiral.

Projections: Orthographic projection, projection of points in different quardrants, projection of lines, projection of lines parallel to one and inclined to the other reference plane, projection of lines inclined to both the reference planes.

Multi view orthographic projections: First angle and third angle projections, conventions used, Conversion of three-dimensional views to orthographic views.

Projection of Solids and Development of surfaces

Isometric projections: Isometric views, conversion of orthographic views to isometric views.

Recommended Books:

1. Engineering Drawing - N D Bhatt
2. Engineering Graphics - S C Sharma & Naveen Kumar
3. Engineering Drawing - P S Gill
4. Engineering Drawing with Auto-CAD - Parvez, Khan & Khalique

MMC 111021/ MMC 12102   MANUFACTURING PROCESSES   [1-4-0]

Carpentry : Classification of timber, seasoning & preservation to wood, description and application of the various tools used in carpentry, different joints and their practical uses.

Forming : Introduction to deformation and forming, types of forming processes and their applications, safety rule.

Casting: Introduction to foundry. pattern making, types of casting processes, purpose of runner and riser. application of casting, defects in casting. safety rules.

Fitting: Introduction to fitting jobs, fitting tools and their uses. safety rules.

Welding: Welding types, accessories, weldments.

Machine Tools: Types of cutting tools, types of machine tools and their specifications, safety rules.

Measurement: Use of measuring instruments etc for product measurement.

Recommended Books:

1. Workshop Technology part I, II & I IJ - W A J Chapman
2. Workshop lechnology part I & II - Hazra Chowdhary
3. Workshop Technology part I & II - Raghuvanshi
4. Workshop Technology - S.K. Garg
5. Manufacturing Technology - P. N. Rao
6. A Text book of Workshop Technology - R S Khurmi & J K Gupta

EEC 11102/12102   ELECTRICAL TECHNOLOGY   [3-0-0]

Concepts of circuit elements: active and passive elements; resistance, inductance, capacitance; mutual inductance and coupling. Network theorems (KCL, KVL, Thevenin, Norton, Maximum power transfer). Mesh and nodal analysis of DC circuits

Single-phase AC circuits and concept of phasor diagram, series and parallel resonance. Three-phase AC circuits with balanced and unbalance loads. Measurement of three-phase power by two-wattmeter method.

Single-phase transformer: construction, types, e.m.f equation, equivalent circuit diagram, hysteresis and eddy current losses, efficiency, applications.

DC Machines construction and types, e.m.f and torque equation. DC generator operation, e.m.f. equation, OCC, losses and efficiency, applications. DC motor operation, torque equation, starting, losses and efficiency, applications.

Three-phase induction motor: construction, types, operation, torque equation, torque slip characteristics, starting methods, applications.

Recommended Books:

1. Electrical Engineering Fundamentals - V Del Toro.

2. Basic Electrical Engineering (Special Indian Edition) - J J Cathey, S A Nasar, P Kumar.

3. Hughes Electrical and Electronic Technology - E Hughes, I M Smith, J Hiley, K Brown.

4. Basic Electrical Engineering - D P Kothari and I J Nagrath.

5. Electric Machinery - A E Fitzgerald, C Kingsley, S D Umans.

EEC11201/12201   ELECTRICAL TECHNOLOGY PRACTICAL   [0-0-3]

Experiments on Thevenin's theorem, R-L-C series circuit, Single phase power measurement, Characteristics of fluorescent lamp and incandescent lamp, OC and SC tests of single phase transformer, Open- circuit characteristics of DC separately excited generator, External Characteristics of separately excited DC generator, Three-point starter of DC shunt motor, Speed control of DC motor.

ECC 11101/12101   ELECTRONICS ENGINEERING   [3-0-0]

Semiconductor Diodes and Applications Introduction Characteristics, dc and ac resistances of a diode. Half wave and Full wave rectification. Zener Diodes and then use as regulators, Clippers and Clampers.

Bipolar Junction Transistor Introduction, Transistor operation CB, CE and CC configuration, dc Biasing, Operating Point, Fixed Bias Circuit, Emitter Stabilized Bias Circuit. Voltage Divider Bias.

BJT Transistor Amplification in ac domain, Equivalent transistor model. Hybrid Equivalent model, RC coupled amplifier and its frequency response.

Operational Amplifiers Introduction, Differential and Common Mode Operation, OPAMP Basics, Practical OPAMP Circuits.

Introduction to Field Effect Transistors and their applications.

Digital Electronics Review of Basic Gates and Boolean Algebra, Introduction to Combinatorial Logic Design. Standard Representations of Logical Functions and their simplification. Combinatorial Logic Design, Half Adder and Full Adder.

Recommended Books:

1. Electronic Device and Circuit Theory - Boylestad & Nashelsky

2. Digital Principles & Applications   - Malvino & Leach

ECC 11201/12201   ELECTRONICS ENGINEERING (LAB)   [0-0-3]

1. Study of Electronic Equipment & Components.

2. Study of diode characteristics.

3. Study of regulated power supply.

4. Study of BJT characteristics.

5. Study of op-amp characteristics.

6. Implementation of Boolean algebra using logic gates.

7. Adder Circuits.

MMC 11103/MMC12103   ENGINEERING MECHANICS   [3-1-0]

Fundamentals of Mechanics: Equivalent force systems, Equilibrium of rigid bodies.

Introduction to structural mechanics: Trusses, Frames, Machines, Beams, and Cables.

Friction force analysis: Sliding and Rolling friction, Screw, Belt and Collar friction

Properties of surfaces: Centroid of composite bodies, Pappus-Guldinus theorem, moment of inertia of composite bodies, parallel axis theorem, product of inertia, principal axes, Mohr's circles for moments and products of inertia.

Virtual work: Principle and applications, Stability of equilibrium.

Kinematics and kinetics of particles: Curvilinear motion, Dynamic equilibrium, Angular momentum, Revision of Conservation of Energy, Energy and Momentum methods for Single Particle and for a System of Particles, Impulsive motion.

Kinematics of rigid bodies: General plane motion, Instantaneous center of rotation, Planer motion relative to a rotating frame, Coriolis acceleration, Frame of reference in general motion.

Kinetics of rigid bodies: Application of the principle of impulse and momentum to the 3D motion of a rigid body, Kinetic energy in 3D, Euler's equations of motion, Motion of a Gyroscope, Eulerian angles.

Recommended Books:

1. Vector Mechanics for Engineers - Statics & Dynamic: Beer, Johnston.

2. Vector Mechanics - Statics & Dynamics: Nelson, Best, McLean.

3. Vector Mechanics - Statics & Dynamics: Shames. Rao, Pearson.

4. Engineering Mechanics: Timoshenko & Young.

CSC 11101/CSC 12101   COMPUTER PROGRAMMING (S)   [3–0–0]

Programming in C

C Fundamentals: Introduction to C, Data types, Constants and variable declaration, Scope, Storage classes, Data input and output functions, Sample programs.

Operators & Expressions: Arithmetic, Relational, Logical, Bitwise operators, Conditional, Assignment, Library functions.

Control & Looping Statements: if, while, for, do-while, switch, break and continue statements, nested loops.

Arrays: Declaration, Initialization, Processing an array, 1D, 2D and multidimensional arrays, Strings and their Operations.

Functions: Defining functions, Function prototypes, Accessing a function, Passing arguments, Passing arrays and Recursive functions.

Pointers: Declaration, Operations on pointers, passing pointers to a function, Pointers and arrays, Array of Pointers.

Structures & Unions: Defining a structure, processing a structure, User defined data types, Structure and pointers, passing structure to a function, Self referential structures, Unions.

File Management: File operations, Creating and processing a data file, Command line arguments.

Programming in JAVA

Fundamentals of Object-Oriented Programming: Basic concepts, Objects and classes, Data abstraction and encapsulation, Inheritance, Polymorphism and Dynamic binding.

JAVA Evolution: Java features, Java versus C and C++, Creating, compiling and running a Java program, Constants, Variables, Data types, Operators and Expressions, Decision making and branching, Decision making and looping, Classes, objects, and methods, Sample programs.

Recommended Book:

1. "Programming with C by Byron Gottfried" , *Second edition*, *Schaum's Outline Series* ,1998

2. "C programming by Kernighan and Ritchie", *Second edition*, *Prentice Hall*, April 1, 1988

3. "Java: The complete reference Herbert Schildt", *Eight edition, McGraw Hill*, 2011.

4. "The *C Programming* Language by Bjarne *Stroustrup*", Pearson Education, 2000.

5. "C: The complete reference   Herbert Schildt", *Fourth edition, McGraw-Hill,* 2000.

6. "Programming With *Java by E Balaguruswamy*", 4th Edition, Tata McGraw-Hill, 2008

7. *"Let us C by Yashwant Kanitkar", BPB publications, 2008.*

CSC11201/CSC12201   COMPUTER PROGRAMMING PRACTICAL   [0–0–2]

Laboratory experiments will be based on the materials covered in the theory of this paper emphasizing the following topics.

1. Control statements

2. Arrays with applications

3. String Handing

4. Structure with applications

5. Pointers with applications

6. File handling in C

7. Programs on Java

(GLD/CMD)(11301/12301)   EARTH SYSTEM SCIENCE (S)   [3-0-0]

Part A: AGL   [2-0-0]

Space Science: Solar System, Age of the Earth, Origin of Solar system. Meteors and Meteorites.

Earth Dynamics: Interior of the Earth, Composition of the Earth, Seismic waves, Seismograph, Plate Tectonics, Basics of Earthquake Engineering, Landslides, Volcanoes.

Geological Oceanography: Sea waves, Tides, Ocean currents, Geological work of seas and oceans, Tsunami and its causes, Warning system and mitigation.

Hydrogeology: Water table, Aquifer, Groundwater fluctuations and groundwater composition, Hydrologic cycle.

Glaciology: Glacier types, Different type of glaciers, Landforms formed by glacier.

Geological bodies and their structures: Rock, mineral, batholith, dyke, sill, fold fault, joint, unconformity.

Part B: E S E
          [1-0-0]

Earth's Atmosphere: Structure and composition of atmosphere, Atmospheric

circulation, Geological work of wind, Greenhouse effect and global warming, Carbon dioxide sequestration. Steps to maintain clean and pollution free atmosphere with governing laws, precautionary measures against disasters.

Biosphere: Origin of life, Evolution of life through ages, Geological time scale, biodiversity and its conservation.

Natural Resources: Renewable and non-renewable resources, Mineral and fossil fuel resources and their geological setting, mining of minerals and conservation, effect of mining on surface environment.

Recommended Books:

1. Earth's Dynamic Systems W. Kenneth and Eric H. Christiansen

2. Exploring Earth: An introduction to Physical Geology John P. Davidson

3. Holmes Principles of Physical Geology   A. Holmes (Revised Ed. Doris L. Holmes)

4. A Textbook of Geology P K Mukherjee

5. Earth System Science from biogeochemical cycles to global changes   M. Jacobson, R.J. Charlson, H. Rodhe and G.H. Orians (2002)

6. Fundamentals of Geophysics W. Lowrie.

(DMS/APD)(11301/12301)   DISASTER MANAGEMENT & ENERGY   [3-0-0] RESOURCES

DISASTER MANAGEMENT(S)   [2-0-0]

Concepts of Disaster, Types of Disaster and Dimensions of Natural and Anthropogenic Disasters (cyclone, flood, landslide, subsidence, fire and earthquake);

Principles and Components of Disaster Management, Organizational Structure for Disaster Management, Disaster Management Schemes;

Introduction to Natural Disasters and Mitigation Efforts: Flood Control, Drought Management, Cyclones, Terror Threats;

Pre-disaster risk and vulnerability reduction; Post disaster recovery and rehabilitation; Disaster related Infrastructure Development;

Role of Financial Institutions in Mitigation Effort;

Psychological and Social Dimensions in Disasters;

Disaster Management Support Requirements Training, Public Awareness.

ENERGY RESOURCES   [1-0-0]

Classification of energy resources and their availability; Renewable and non-renewable energy sources; World energy prospects; Environmental impacts; Energy, power and electricity; Energy scenario in India: Availability of conventional

and nonconventional energy resources and future energy demand; Indian reserves and resources of natural oil and gas, coal and nuclear minerals; Potential of hydroelectric power, solar energy, thermal, nuclear, wind, tidal wave and biomass based power in India; Introduction to hydrogen energy and fuel cells.

Books Recommended:

1. Non-Conventional Energy Sources by G.D.Rai, Khanna Publishers.

2. Fundamentals of Renewable Energy Resources by G.N. Tiwari & M.K. Ghosal, Alpha Science International.

3. Solar Energy: Fundamentals and Applications by H P Garg & J Prakash, Tata McGraw-Hill Publishing Company Ltd.

4. Solar Energy: Principles of Thermal Collection and Storage by S P Sukhatme, Tata McGraw-Hill Publishing Company Ltd.

HSS11305/HSS12305   VALUE EDUCATION, HUMAN RIGHTS AND [3-0-0] LEGISLATIVE PROCEDURE

Social Values and Individual Attitudes, Work Ethics, Indian Vision of Humanism, Moral and Non-moral Valuation, Standards and Principles, Value Judgements.

Rural Development in India, Co-operative Movement and Rural Development.

Human Rights, UN declaration, Role of various agencies in protection and promotion of rights.

Indian Constitution, Philosophy of Constitution, Fundamental Rights and Fundamental Duties, Legislature, Executive and Judiciary : Their Composition, Scope and Activities.

The Legislature: Function of Parliament, Constitution of Parliament, Composition of the Council of the States, Composition of the House of People, Speaker.

Legislative Procedure: Oridinary Bills, Money Bills, Private Member Bills; Drafting Bills; Moving the Bills, Debate, Voting, Approval of the President/Governor.

Vigilance: Lokpal and Functionaries.

HSS 11101/HSS12101 ENGLISH FOR SCIENCE AND TECHNOLOGY [3-0-0]

Language Resource Development: Using appropriate grammatical lexical forms to express meaning-accuracy, range and appropriacy in grammatical lexical exercises.

Reading, Interpreting and Using Written, and Graphic Information : Using (reading and writing) academic texts, articles in technical journals, instruction manuals/laboratory instruction sheets, safety manuals and regulations, and reports; Using maps, graphs, plan diagrams, flow-charts, sketches, tabulated and statistical data.

Writing Appropriately in a Range of Rhetorical Styles i.e. Formal and Informal : Writing instructions, describing objects and processes; defining, narrating,

classifying exemplifying, comparing, contrasting, hypothesizing, predicting, concluding, generalizing restating, and reporting; Note making (from books/journals); Writing assignments; summarizing, expanding, paraphrasing; Answering examination questions; Correspondence skills; Interpreting, expressing and negotiating meaning; Creating coherent written tests according to the conventions.

Receiving and Interpreting the Spoken Word : Listening to lectures and speeches, listening to discussions and explanations in tutorials; Note taking (from lectures); Interacting orally in academic, professional and social situation; Understanding interlocutor, creating coherent discourse, and taking appropriate turns in conversation; Negotiating meanings with others (in class room, workshop, laboratory, seminar, conference, discussion, interview etc.).

Recommended Books:

1. Robert, E. Dewey and Robert, H, Hurlbutt III. An Introduction to Ethics, Macmillan Publishing co. int., New York, 1977.

2. Radakrishnan, S. Mahatma Gandhi: Essays and Reflections. Jaico Publishing House, Mumbai, 1957.

3. Gandhi, M K. An Autobiography; The Story of My Experiment with Truth. Navjeevan Trust, Ahmadabad, 1927.

4. Leah Levin. Human Rights: Questions and Answers, National Book Trust, New Delhi, 1998.

5. Basu, Durga Das, Introduction to Constitution of India, Prentice Hall of India Pvt. Ltd., New Delhi, 1994.

Course Content second year onward

Third Semester

CHC 13101   **Fluid Mechanics**   **3-1-0**

Course content

Fundamental concepts of fluid flow, mechanism of compressible and non compressible fluid flow, equation of continuity, Reynolds number, significance, Bernoulli's theorem, distribution of velocities and fluid flow profiles, friction factor and friction losses in pipes, roughness factor and its significance, pipe fittings, equivalent length of fittings etc. Energy losses due to sudden contraction and expansion.

Measurement of fluid flow: orifice meter, venturi meter, pitot tube, rota meters, notches and weirs, gas flow meters, coefficient of discharge and calculations.

Transportation of fluids, reciprocating and centrifugal pumps, pump characteristics, Diaphragm pumps, rotary pumps, screw pumps, gear pumps, pump power calculations, pump selection and trouble shooting of pumps, priming, cavitation , NPSH of pumps.

Packed Bed, pressure drop in packed beds, packing materials and their selection criteria, Loading and flooding in packed beds, Ergun equation.

Fluidization, aggregate and particulate fluidization, incipient fluidization, minimum fluidization velocity, entrainment in fluidization, operating characteristics of gas solid, liquid solid and liquid gas and gas solid liquid (three phase) fluidized beds.

Pneumatic conveying of solids.

CHC13102   **Chemical Process Calculations**   **3-1-0**

Course Content

Steady-state and dynamic processes; lumped and distributed processes; single and multi-phase systems; intensive and extensive variables; equilibrium relations; rate laws; correlations for physical and transport properties; behavior of ideal gases and gaseous mixtures; vapor pressure; humidity and saturation; phase equilibrium; non-reacting single-phase systems; systems with recycle, bypass and purge; processes involving vaporization and condensation; enthalpy; heat of reaction; thermochemistry; fuel calculations; computer based calculations for energy balance; flow-sheeting; degree of freedom and its importance in flow-sheeting; use of spread sheet, tearing and iteration in flow-sheeting.

Units, Dimension & Dimensional Analysis.

ACR 13101   **Chemistry for Chemical Engineers**   **3-0-0**

Course Content

Chemistry of Polymers; Chemistry of Dyes; New Chemical Technologies for Synthesis; Organic chemistry of drug synthesis; Biological Chemistry;

Radioactivity; Electrochemistry and Corrosion; Particles and Colloids; Fundamentals Green Chemistry, Carbon Capture and Storage.

Conductance determination, conductometric titration, transport number determination, concentration cells, Standard cells, standard electrode potentials, application of EMF measurement, storage batteries, hydrogen ion concentration, , hydrolysis of salts, dissociation constants of acids and bases and solubility product, theory of acid-base indicators. Radiation chemistry, laws of photochemistry, photo chemical reactions, combination of hydrogen and chlorine, flash photolysis and radiolysis.

MMR 13101   Mechanical Engineering-I   3-1-0

Course content

Introduction to Strength of Materials; Stress-strain diagram; Elastic constants and their relations, Thermal stresses and strains; Stresses in oblique planes- Principal stresses and principal planes. Theory of simple bending; Deflection of beams- integration method and moment area method.

Analysis of stresses in pressure vessels - thin and thick cylinders. Torsion of solid and hollow circular shafts.

Introduction to theory of Machines; Basic concepts; degrees of freedom, kinematic constrains, linkages, mechanisms. Different types of gears, gear trains, reduction ratio and torque assessment, application of gearboxes. Basic principles and constructions of governors, flywheels, brakes, clutches and dynamometers.

Case study based on laboratory setups on the above broad areas

AMR 13101   Methods of Applied Mathematics-I   3-1-0

Course content

Part-I:

Complex Variables:

Limit, continuity and differentiability of function of complex variables. Analytic functions. Cauchy-Riemann's equations, Cauchy's integral theorem, Morera's theorem, Cauchy's integral formula, Taylor's and Laurent's series, singularities, Residue theorem, contour integration.

Special Functions:

Solution of Bessel equation, recurrence relations and generating function for , orthogonal property and integral representation of . Solution for Legendre equation, Legendre polynomial, Rodrigue's formula, orthogonality property and generating function for .

Part-II:

Laplace Transform:

Laplace transform of simple functions, properties of Laplace transform, t-

multiplication and t-division theorems, Laplace Transform of derivatives, integrals and periodic functions. Inverse Laplace transform and its properties, convolution theorem. Use of Laplace transform in evaluating complicated and improper integrals and solution of ordinary differential equations related to engineering problems.

Partial Differential Equations:

Classification of partial differential equations, solutions of one dimensional wave equation, one dimensional unsteady heat flow equation and two dimensional steady heat flow equation by variable separable method with reference to Fourier trigonometric series.

HSC   **Humanities and Social Sciences**   **3-0- 0**

OPTION-I HSE13302   Philosophy of Science

1. **Introduction:** Rationale for study of Philosophy of Science prevalence of imbalances; General Approach, Nature, Scope and Relation of the subject with Historical Development.; Science and Philosophy vis-à-vis need for Intellectual and Moral Balance. Scientific and Philosophical approaches to knowledge development and Knowledge application (Emphasis on Earth and Mineral Sciences)

2. **Foundations of Philosophy:** Nature, Concept, Scope, Methodology, Divisions and Implications.

3. **Concept and Nature of Science:** Origin/Aim, Methodology, Scope and Development: Nature of Scientific Methods; Movements; Scientific Thought; Divisions of Science; Scientific Laws and Scientific Explanations.

4. **Convergence of Science and Philosophy:** Unified Theory; Space Time Relationship; Patterns of Change; Deeper issues and broad involvements of Science; Status of Scientific Proposition and Concepts of Entities, Epistemic and Ontological aspects.

5. **Philosophical Analysis and Scientific Practice:** Philosophical Base of Eastern Thought and their parallel in Science; The Essential of Unity between Eastern Thought Pattern and Western Science, Need for harmony between Intuitive Thought and Rational Knowledge; Philosophers of Science with reference to Western Thought, Philosophers of Science Western and Eastern.

6. **Inter-relationship of Science and Culture:** Science and Aesthetics, Science and Human Values, Science in the full tradition, Science vis-à-vis Human Conduct and Social Affairs; Social Significance of Science; Implications of Philosophy of Science for a new peaceful Social Order, Synthesis of Eastern "World View" and Western "Materialism".

OPTION-II HSE13303   GANDHIAN STUDIES

1. Introduction to Gandhi's Life and Philosophy; Fundamentals of Gandhian Economics; Gandhi's Concept of Human Nature, Perfectibility of Man; Ethical

Ideas of Gandhi- Truth, *Ahimsa*, *Brahmacharya*, Non-stealing, Non-possession and Voluntary Poverty. Gandhi's Interpretation of History and Society.

2. Public Welfare and Sarvadoyo Philosophy *Antyodaya*; *Sarvadoya* Socialism and Capitalism; Nature of *Sarvodaya's* Economy from Gandhi to Vinobha; Concept of Production and Distribution in *Sarvodaya* Economy and it's Utility in our Socio-economic and Scientific/ Technical Development; Non- violent Economy vis-à-vis Centralized Industrial Economy and Rural Economy.

3. Study of the Current Industrial Problems and Priorities as against the Gandhian Ideology.

4. Gandhian approach to Man-power Management, Prospects, Co-operative Production and Consumption, Rural Entrepreneurship, Finance, Plan changes for helping the disadvantaged sections of the society.

5. Man and machine- Problems of Automation and Gandhi's View.

6. Gandhi's Political Views: The State as an organ of Violence, Political Sovereignty of the People, Decentralization of Political Power, Concept of Freedom, The Idea of Political Condition- **Ram Rajya**.

7. Satyagraha: The Importance of Truth Force, Self Suffering, Winning over the opponent by Love.

8. Relevance of Gandhian Ideas in the contemporary Economic and Political situation.

Note: Use of Video Films shall be made to support the classroom teaching.

OPTION-III HSE13304   **Oral Communication Skills**

The nature, purpose and characteristics of good conversation, Phonological forms to use in speech, Developing conversation skills with a sense of stress, intonation   , and meaning, Use of question tags, Starting, maintaining and finishing conversations, Standard conversational exchange, Spoken language idioms, Effective listening and attention to others, Gestures and body language, Do's and Don'ts in conversation, Telephonic conversation, Functions of English in conversation: introductions, greetings, clarifications, explanations, interruptions, opinions, Agreement and disagreement, complaints, apologies, Participating in informal discussions and situations, Using information to make some decision, i.e., making social arrangements with friends, Reproducing information in some form (question/answer summarizing, oral reporting, etc.)

OPTION-IV HSE13305   Oral Presentation Skills

Characteristics of good presentation, Assessing the audience and its needs, Planning a presentation, Different presentation styles, Using the presentation matrix, The informative presentation, The demonstrative presentation, The persuasive presentation, Presentation structure and design, Materials and logistics, Visual aids and their development and use, Rehearsing and delivering,

Using performance techniques, Overcoming anxiety and stress, Opening and closing, Getting and maintaining audience attention, Using language to optimal effect, Body language and gestures, Linguistic aspects: introducing, sequencing, signaling, quoting, clarifying and summarizing, Handling questions

OPTION-V HSE13306 LITERARY COMMUNICATION

Exposer to recent literary and creative trends in English and their relation with the values, culture and norms of behaviour; linguistic and cultural process. What and how of literary communication for improvement of proficiency in the use of English language.

Analysis and interpretation of five to six recent short stories from different parts of the world to make the sensitive and different intensification of the skills of conceiving the ideas, situations and solutions, and rendering them into appropriate expression on a higher plane of finish

OPTION-VI HSE13307 PRESENT HISTORY OF INDIA

Idea of a Nation: Defining Nation, Citizenship Duties, Profession, Society, Modern Nation- State as it emerged after 1789, The Socio-Economic context of the new 'Nation'.

The Modern Individual: Transition from pre-modern definition and social location of Individuals to the growth of idea of free Individual, Social Contract, The Duties of an Individual, Atomization of Individual and a critique to it.

Colonial Rule in India: Colonial redefinition of Nation, Individual, Society in India- a critique of Pre-colonial mode of life by the colonial theorists, The 'Progressive' colonial alternatives, the ambiguity in colonial 'Image' of India.

Nation and the Nationalists: The Ideological Contestation of Colonial Images by the Nationalists, Critique of Colonialism by Gandhi, Nehru, Tagore, S.C. Bose, Aurobindo Ghosh, M.N. Roy, J.P. Narayan. Problamatizing Colonial Ideas, Impact of Colonialism in India, Problems with the Nationalist Critique of Colonialism. Colonialists and Nationalists on the idea of 'Science', 'Modernity' and 'Development'.

Re-inscribing Indian Feminity: Changing Views of Indian Feminity vis-à-vis female Sexuality.

Threats of Neo-Colonialism: The Challenges to the Nation, Post Colonial Critique of Colonialism and Nationalism, Individual and Society in a Changing World Order.

OPTION-VII HSS 351/13301 HISTORY OF SCIENCE AND TECHNOLOGY

Introduction to the History of Science- Emergence and Character of Science, Science in the Ancient world, The Dawn of History: Babylon-China-India, Classical Science. Greek and Romans, Science during the Medieval Age, The Dark Age, The Arabian and the Indian Science, Birth of Modern Science: Renaissance and Scientific Revolution, Eighteen-Century Science, Application of Science,

Industrial Revolution, Causes and Consequences, Present Day Science, Impact of Science on Society, Growth of Indian Mineral Industry, including Mining and Petroleum Industry

CHC 13206	**Fluid Mechanics Lab**	**0- 0-3**
CHC 13207	**Instrumental Methos of Analysis**	**0-0-3**
CHC 13208	**Project**	**0-0-2**

Fourth Semester

CHC 14101   **Heat Transfer**   **3-1-0**

Course content

Basic modes of heat transfer:

Conduction: basic equations of one-dimensional, two-dimensional and three-dimensional conduction; steady conduction in slabs, cylinders and spheres; critical thickness of insulation; transient conduction: analytical solution for slabs; use of transient temperature charts for slabs, cylinders, and spheres; lumped system of analysis.

Convection: equation of motion; equation of energy; hydrodynamic and thermal boundary layers; natural convection; forced convection inside tubes, over cylinders and spheres in laminar and turbulent conditions; Empirical equations for free and forced convection; boiling and condensation heat transfer.

Radiation: black body and gray body radiation; shape factor; Kirchhoff's law; Radiation shields; radiation from gases.

Basic types of heat exchangers; overall heat transfer coefficient; Laminar & turbulent flow; LMTD method, effectiveness-NTU method.

Evaporation: evaporator capacity, economy and types; single and multiple effect evaporators, forward and backward feed evaporation, evaporator calculations.

CHC 14102   **Chemical Engineering Thermodynamics**   **3-1-0**

Course content

Basic Concepts and First Law of Thermodynamics: Basic concepts: work, energy, heat, internal energy, extensive and intensive properties, state and path functions, First law of thermodynamics, energy balance for closed systems, equilibrium, the reversible process, constant-v and constant-p processes, enthalpy, heat capacity, energy balances for steady-state flow processes.

Volumetric Properties of Pure Fluids: PVT behavior of pure substances, virial equations of state, the ideal gas, equations for process calculations: isothermal process, isobaric process, isochoric process, adiabatic process, and polytropic process. Application of the virial equations, introduction tocubic equations of state: vander Waals equation, Redlich/Kwong equation, theorem of corresponding states; acentric factor.

Second Law of Thermodynamics : Statements, heat engines, Carnot's theorem, ideal-gas temperature scale; Rankine cycle, concept of entropy, entropy changes of an ideal gas undergoing a mechanically reversible process in a closed system, mathematical statement of the second law, entropy balance for open systems, statement of the third law of thermodynamics.

Thermodynamic Properties of Fluids: Property relations for a homogeneous fluid of constant composition in a closed system: Maxwell's equations, enthalpy

and entropy as functions of T and P, internal energy as a function of P, internal energy and entropy as functions of T and V. Two-phase systems: temperature dependence of the vapor pressure of liquids, two-phase liquid/vapor systems.

Thermodynamic diagrams. Tables of thermodynamic properties.

CHC 14103   **Mechanical Operations**   **3-1-0**

Course content

Introduction to unit operations and their role in Chemical Engineering industries. Types of Mechanical Operations, Characteristics of particulate solids: sampling techniques, specification and screen analysis, particle size distribution.

Principles of size reduction: Specific properties of solids for size reduction. Energy required for size reduction. Crushing and grinding efficiency. Laws of crushing, pulverization and ultrafine grinding. Classification of crushing and grinding equipment. Construction and working principle of mostly used equipments, viz., Jaw crushers, gyratory crushers, hammer mill, crushing rolls, ball mills, and fluid energy mills. Mixing of solids, blending, kneading, etc.

Screening, classification of screening equipments. Mechanical classification and classifiers.

Separation methods for different types of mixtures: Rare and dense medium separation, magnetic separation, electrostatic separation. Floatation and elutriation. Continuous thickeners, decantation, Gravity settling, Impingement separators, Cyclone separators, bag filters, scrubbers . Filtration: classification of filters, theory of filtration.

Conveying of bulk solids, classification of conveyors, selection of conveyors.

Flow assisting devices, feeders.

ACR 14101   **Material Science and Technology**   **3-0-0**

Course content

Introduction to material science, Classification of engineering materials,

Geometry of crystals- the Bravais lattices, Crystal directions and Planes- Miller indices, Structure determination-X ray diffraction- Braggs Law, the power method.

Point Imperfections, Line imperfections- edge and screw dislocations, Surface imperfections.

Phase rule, Single component systems, Binary Phase Diagrams, Lever rule, Typical Phase diagrams for Magnesia-Alumina, Copper-Zinc, Iron-carbon system, Nucleation and growth, Solidification, Allotropic transformation, Cooling curves for pure iron, Iron-carbon equilibrium diagram, Isothermal transformations (TTT curves).

Elastic deformation, Plastic deformation, Creep, Visco-elastic deformation, Different types of fracture.

Annealing, Normalizing, Hardening, Martempering, Austempering, Hardenability, Quenching, Tempering, Carburising, Cyaniding, Nitriding, Flame hardening.

Corrosion and prevention: Direct Corrosion, electro-chemical corrosion, Galvanic cells, High temperature corrosion, Passivity, factor influencing corrosion rate, Control and of corrosion-modification of corrosive environment, Inhibitors, Cathodic protection, protective coatings. Corrosion charts.

Ferrous metals, Non ferrous metals and alloys, Ceramic materials, Polymorphism, Smart materials, biomaterials, nanomaterials, polymers and composites.

AMR 14101   Numerical and Statistical Methods   3-1-0

Course content

Part-I: Numerical Methods

Solution of algebraic and transcendental equation by bisection, iteration, false position and Newton-Raphson methods.

Solution of a system of linear simultaneous equations by Gauss elimination, Gauss-Jordan, Crout's triangularisation, Jacobi and Gauss-Seidel methods.

Finite difference, Symbolic relations, Interpolation and Extrapolation, Newton-Gregory forward and backward, Gauss forward and backward, Stirling, Bessel and Lagrange's formulae, Inverse interpolation by Lagrange and iterative methods, Numerical differentiation and integration: Trapezoidal, Simpson's $1/3^{rd}$, Simpson's $3/8^{th}$ and Weddle quadrature formulae.

Numerical solution of first order ordinary differential equations by Taylor's series, Picard's, Euler's, Modified Euler's, Runge-Kutta and Milne's methods. Solution of simultaneous first order and second order ordinary differential equations with initial conditions by Runge-Kutta and Milne's methods. Numerical solution of boundary value problems by finite difference method.

Part II: Statistical Methods

Moments, skew ness and kurtosis.

Probability: Various approaches of probability, two theorems (without proof), conditional probability, Bayes theorem.

Random variable: Definition, probability mass & density functions, distribution function, mathematical expectation and moment generating function.

Probability distributions: Bernoulli, binomial, Poisson and normal distributions.

Theory of least squares and curve fitting.

Correlation and Regression: Simple, multiple & partial correlation coefficients, regression lines, regression coefficients and their properties.

Test of significance: Normal test, t-test, chi square test and F test.

HSC 14306   **English for Professional Communication**   **3-0-0**

Course content

1. Need of professional communication; Barriers to communication and overcoming the barriers.

2. **Report Writing :** Types of report (formal/informal), Mechanics of report writing; Gathering of material, shifting and editing of material, the outline and the first draft, style and presentation; Report structures; The use of footnotes and references, tables, figure, and appendices.

3. **Official communication :** Formal style of communication, Formal and business letters, ssentials of a business letter, mechanics of writing a formal business letter, drafting the letter - the format and style; Letters of requests; Letters of instructions, Letters of complaining C.V. preparation, its contents, style and presentation, Accepting an offer, declining an offer; writing memos, memo vs. letter, essential features of a good memo style.

4. **Interviews and public speaking :** Preparation for an interview, upholding the personality, interview techniques; group discussions, beginning the discussion, poise and delivery - style and presentation, fallacies in argument and rebuttal, positive group behaviour, some pitfalls in discussion.

Scope of Practice Sessions:

CHC 14201   **H e a t   T r a n s f e r   L a b**
        0-0-2

CHC 14202   **Mechanical Operation Lab**   **0-0-2**

CHC 14210   **Project Work**   **0-0-2**

Fifth Semester

CHC 15101   **Chemical Reaction Engineering - I**   **3-1- 0**

Course content

Chemical equilibria - Free energy and chemical reactions, feasibility of chemical reaction, calculation of free energy of homogeneous reactions, equilibrium constants and evaluation from thermodynamic data, effect of different variables on reaction equilibria, calculation of equilibrium composition for single and multiple reactions, equilibria of heterogeneous reactions.

Kinetics of homogeneous reactions - introduction, single and multiple reactions, elementary and non-elementary reactions, rate equations, kinetic models for non-elementary reactions, testing kinetic models, temperature dependence of rate - Arrhenius, collision and activated complex theories, Interpretation of batch reactor data for single and complex reactions under constant volume and variable volume conditions, differential and integral analysis, half life period.

Design of single homogeneous reactors - ideal reactors, design equations for ideal batch reactor, PFR and CSTR, size comparison of single reactors, optimum reactor size problems.

Multiple reactor systems - plug flow reactors in series and / or parallel, CSTRs in series, reactors of different types in series, recycle reactor, auto catalytic reactions, optimum recycle ratio for an auto catalytic reaction.

Multiple reaction systems - series and parallel reactions in CSTRs and PFRs, product distribution, fractional yields, maximization of fractional yield in multiple reactions, series - parallel reactions.

CHC 15102   **Chemical Engineering Thermodynamics - II**   **3-1-0**

Course content

NonIdeal behavior: Partial properties and their evaluation, Fugacity and fugacity coefficient of pure substances and components in solution, generalized correlations for the fugacity coefficient, excess properties. Activity coefficient and its estimation from VLE data: van Laar equation, Margulus equation, Willson equation, Gibbs Duhem's equation.

Introduction, duct flow of compressible fluids: pipe flow, nozzles, throttling process.

Compression processes: compressors, pumps, introduction to ejectors.

Carnot refrigerator, vapor-compression cycle, choice of refrigerant, absorption refrigeration, heat pump, liquefaction processes: Linde liquefaction process, Claude liquefaction process.

The nature of equilibrium, phase rule: Duhem's theorem, Pxy and Txy diagrams, simple models for VLE, Raoult's law, Dew point and bubble point calculations with

Raoult's law for binary mixtures, Henry's law, VLEby modified Raoult's law, VLE from K-value correlations, flash calculations.

Reaction coordinate, application of equilibrium criteria to chemical reactions, standard Gibbs-energy change and the equilibrium constant, effect of temperature on the equilibrium constant, evaluation of equilibrium constants. Relation of equilibrium constants to composition: gas-phase reactions, liquid-phase reactions, equilibrium conversions for single reactions: single- phase reactions.

CHC 15103   Energy Resources and Utilisation   3-0-0

Course content

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

Coal its origin and formation, Coal analysis, Coal classification, Coal preparation, Coal washing and coal blending, Coal carbonization, Coal gasification, liquid fuel synthesis from coal, coke oven gas, blast Furnace gas, CBM.

Petroleum crude, Types of crude, emergence of petroleum products as energy, Gaseous Fuels: Natural gas, Water gas, producer gas, L.P.G., LNG, CNG, GTL Technology (gas to liquid).

Fuel cell , Bio energy, biogas plants and their operation , biomass and its conversion roots to gaseous and liquid fuels,wind energy and its potential and generation by wind mills.

Solar Energy; Hydroelectric potential and its utilization & production, Geothermal energy and its potential status and production, Nuclear energy, Cogeneration of fuel and power, Energy from tidal and ocean thermal sources, MHD systems, Biodiesel, Gas hydrates.

Energy Conservation.

CHC 15104   M a s s   T r a n s f e r   -   I
3-1-0

Course content

Fundamentals of Mass Transfer: Molecular diffusion, mass transfer coefficient and interface mass transfer, steady and unsteady state theories of mass transfer, analogy.

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.

Multistage contact operations, Characteristics of multistage tower, McCabe Thiele method, Ponchon Savarit 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.

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.

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.

Description of adsorption processes and their application, Types of adsorption, Nature of adsorbents adsorption equilibrium and adsorption hysterises, Stage wise and continuous contact adsorption operations, Determination of number of stages,

Ion exchange, osmosis and reverse osmosis, thermal diffusion, sweep diffusion.

CSR 13101   **Data Structures**   **3-0-0**

Course content

Data structure overview, Data types, Creation and analysis of programs, Algorithm analysis; Different data structures: Arrays, Stacks, Queues, Circular queues, Priority queues, Linked lists together with the algorithms for their implementation and uses; Sorting algorithms: Insertion, Selection, Bubble, Quick, Merge, Heap etc.

Searching algorithms: Linear searching, Binary searching, Hashing strategy, Hashing functions and hash search.

Trees: Binary tree representation, Traversals, binary search tree, AVL trees, Balancing, Rotations, Applications; Graphs: Representation, Traversals, Shortest-path problems, Applications; Recursive: Divide and conquer, Tower of Hanoi etc.

CHC 15105   **Elements of Biochemical Processes (Sessional)**   **3-0-0**

Course content

Introduction to microbiology and biochemistry; Classification and characteristics of microorganism;

Essential chemicals of life- lipids, sugars and polysaccharides, RNA and DNA, amino acids and proteins; Cell metabolism; Regulation; Stoichiometry; End products.

Cell growth kinetics; Product formation kinetics. Transport phenomena in cellular systems; Oxygen transfer rates; Mass transfer coefficient and interfacial area; Mechanical agitation and power requirement.

Thermal death kinetics; Media and air sterilization.

Enzymes and their classification; Enzyme kinetics; Immobilization of enzymes and whole cells; Immobilized enzyme kinetics.

Bioreactors: Type, design, operation and scale-up; Instrumentation and control.

Down-stream processing, Industrial production of ethanol, anti-biotics, single cell protein. Bioleaching.

CHC 15201	**Chemical Reaction Engineering Lab**	**0-0-3**
CHC 15202	**F u e l A n a l y s i s L a b**	**0-0-2**
CHC 15209	**Project Work**	**0-0-4**

Sixth Semester

CHC 16101 **Chemical Reaction Engineering -II** **3 -1-0**

Course content

Non-isothermal reactions - temperature effects on chemical reaction rates, design procedures for adiabatic and non-isothermal operation of batch and flow reactors, optimum temperature progression, operating temperature for favorable product distribution in multiple reactions, reactor stability.

Non-ideal reactors - Reasons for non-ideal flow behaviours, concept of mixing - micro and macro mixing, residence time distribution (RTD) functions, C, E and F curves, calculation of mean residence time from E and F curves, Tanks in series models, Axial dispersion model, segregated flow model, conversion in non-ideal reactors, introduction to multi-parameter models.

Fluid-solid noncatalytic reactions - shrinking core model, determination of the rate controlling step, conversion in reactors with constant fluid composition, conversion in reactors with variable fluid composition - fixed bed reactor, moving bed reactor.

Gas-liquid non-catalytic reactions - models for transfer at gas-liquid interface, enhancement factor, Hatta number, Derivation of overall rate equation for first order irreversible reaction and instantaneous reaction, design of packed bed reactors for gas-liquid non-catalytic reactions (simple cases).

Solid catalysts - characteristics, classification of catalysts, selection and preparation of industrial catalysts, promoters and inhibitors, catalyst deactivation. Kinetics of solid catalysed reactions - Langmuir-Hinshelwood-Hougen-Watson mechanism, interpretation of kinetic data, redox rate equation, kinetics of catalyst deactivation.

Reaction and diffusion in porous catalysts - effectiveness factor, Thiele modulus, non-isothermal effectiveness factor, Global rate equations. Heterogeneous catalytic reactors - Fixed bed reactors, fluidized bed reactors, slurry reactors, Trickle bed reactors, design aspects with some simple examples.

CHC 16102 **Chemical Process Technology** **3-0-0**

Course content

Section A: Inorganic Chemical Technology

Indian inorganic chemical industry   An overview, Chlor Alkali Industries: Manufacture of Sodium Chloride, Soda Ash, Sodium bi-carbonate, Chlorine and Caustic Soda.

Manufacture of Sulphuric acid, Hydrochloric acid and Nitric acid

Ceramics, Glass and Cement, Paint, Varnish, Enamel and Lacquer, White Lead, Zinc Oxide, Lithopone: Titanium dioxide.

Synthesis of Ammonia, Urea, Diammonium Phosphate, Nitrogen Fertilizers.

Manufacturer of phosphorous, Phosphoric Acid, Super phosphate and Triple super phosphate. Potassium industries: Potassium chloride and potassium sulphate.

Aluminiam Sulphate, Bromine and Bromides, Fluorine and Flurochemicals, Hydrogen peroxide, Calcium Carbide.

Section- B: Organic Chemical Technology

Edible and Essential oils, soaps, and detergents, glycerin, paper and pulp, starch and starch derivative, sugar cane.

Methanol, Formaldehyde, Ethylene and acetylene, Propylene, Chemical from aromatics, Benzene, toluene, xylene and naphthalene.

Production of thermo plastic and thermo setting resins such as polyethylene, polypropylene, phenolic resins, and epoxy resins, polymers and their engineering applications.

Polyamides, polyesters and acrylics from monomers processes for the production of natural and synthetic rubbers, leathers dyes and intermediates.

CHC 16103   Process Equipment and Piping Design   3-1-0

Course content

Section-A

Detailed design and drawing of enclosures, supports and standard flanges, storage vessels including Unfired Pressure Vessels, Reaction Vessels.

Cyclone Separator and Gravity Thickener: Detailed Design And Drawing Of Cyclone Separator And Gravity Thickener.

Cooling Towers: Detailed Design and Drawing of Cooling Towers.

Heat Exchangers: Detailed Design And Drawing of Various Types of Heat Exchangers.

Distillation Column: Detailed Design And Drawing Of Distillation Column.

Absorber: Detailed Design and Drawing of Absorber.

Dryer: Detailed Design and Drawing of Dryer.

Section-B

Fundaments of fluid flow through pipes-Calculation of pressure drop for Newtonian & non-Newtonian fluids, incompressible & compressible fluids and two-phase flow, Calculation of Economic pipe diameter, insulation thickness, equivalent length, Slurry transport and pipelines Engineering flow diagram, nomenclature and equipment elevation.

Piping layout, line pressure drop, piping analysis, stress analysis of curved pipelines, yard piping, Piping codes, standards and specifications-ASME, ASTM, API Piping components-pipes, pipe ends, pipe fittings, end fittings, flanged joints,

valves, valve codes and standards, valve classification, valve components, bolts, gaskets (fasteners and sealing elements)Piping materials-selection, cost and installation Design of heat exchanger piping, Thermosyphonre boiler piping, Pressure relief piping Steam tracing design, Thermowell design, Expansion loops and expansion joints Design of pipeline network-Pinch analysis Pipeline operation and maintenance-friction reduction, cleaning, coating, wear, leak detection, water hammer.

CHC 16104　　　　　　　　**Mass Transfer-II**　　　　　　　　**3-1-0**

Course content

Absorption and Stripping: Equipments, Gas-liquid equilibrium, 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.

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.

Drying: Solid-gas equilibrium, 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.

Crystallization: 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.

Membrane separation process: Different types of membranes and membrane separation processes, pervaporation, Desalination.

CHC 16105　　　　**Process Control and Instrumentation**　　　　**3-0-0**

Course content

Importance, aims and objectives of process control.

Laplace transform, block diagram, Forcing function, Concept of transfer function; dynamics of first, second and higher order linear systems, open loop and closed loop systems; linearisation; feed back control; stability; root locus diagram; frequency response analysis; Bode stability criterion; Nyquist stability criterion; design of controller; dynamics of some complex processes; control valves and introduction to real time computer control of process equipment; cascade, feed forward, adaptive control; SISO; MIMO.

Application of control systems to chemical process equipments such as chemical reactors, heat exchangers, distillation columns, boilers etc.

A/D conversion, PLC architecture; Multi-variable control strategies.

Principles of measurement. Error Analysis, Static and dynamic characteristics of instruments.

Industrial instruments for measurement of pressure, temperature, flow and level.

MSR 14151   Managerial Economics (Sessional)   3-0-0

Course content

Nature, scope and methods of managerial economics.

Managerial Economic Concepts Incremental concept; Opportunity Cost concept; Equi-marginal concept; discounting concept; Risk & Uncertainty.

Law of Diminishing Marginal Utility.

Demand Analysis Meaning & type; Law of Demand features; Exceptions; Market Demand Schedule & Curve; Elasticity of Demand Price elasticity, cross elasticity & income elasticity.

Indifference Curve approach and its properties.

Supply its law, elasticity & curve.

Types of markets; Pricing under various market conditions Perfect competition, imperfect competition & monopolistic competition.

Profit & Profit measurement.

Inflation meaning; Demand-pull, cost-push inflation; Inflationary gap; Causes and steps to control inflation.

National Income Concepts & methods of measurement; Difficulties in measuring national income.

CHC 16204   Mass Transfer-Lab   0-0-3

CHC 16205   Process Control and Instrumentation Lab   0-0-2

CHC 16209   Project & Seminar   0-0-4

Seventh Semester

CHC 17101   Chemical Process Plant Design and Economics   3-1-0

Course content

Basic considerations in Chemical Engineering Plant Design. Project identification, preliminary teachno-economic feasibility. Process design aspects-process selection, factors affecting. Importance of laboratory development, pilot plant, scale-up methods, safety factor's, flow diagrams.

Selection of process equipments-standard Vs special equipments, selection Criteria, specification sheet, Process auxiliaries - piping design, layout, process control and instrumentation, Process utilities-process water, boiler feed water, wastes treatment & disposal, Oil heating system, chilling plant., compressed air vacuum.

Interest-types & calculations. Cost estimation-factors involved in project cost estimation, total capital investment, fixed capital and working capital, Methods of estimation of investment. Cost index and scaling for equipment cost. Estimation of total product cost-factors involved.

Depreciation-types & methods of determination. Profitability - alternative investment and replacement methods, practical factors in alternative & replacement investment.

Inventory control, scheduling a project using CPM/PERT. Project management. Optimum conditions-optimum production rates in plant operations, optimum conditions in cyclic operations. Design reports. Plant location and layout principles, factors affecting, use of scale methods, case studies.

CHC 17102   Transport Phenomena   3-1-0

Course content

Introduction to transport phenomena; Potential flow, Turbulent flow; molecular transport mechanisms and general properties; analogies amongst momentum, heat, and mass transport; boundary layer analysis for momentum, heat, & mass transfer; estimation of transport coefficient, non-Newtonian fluids, rheological characteristics of materials, agitation of non-Newtonian fluids. Heat & mass transfer with and without chemical reaction, non-isothermal, unsteady state processes with and without chemical reactions.

CHC 17103   Process Utilities and Energy Management   3-1-0

Course content

Section-A: Process Utilities

1. Importance of process utilities in chemical industries and plants. Introduction to the use of various utilities.

2. Water as a utility in process industries, conservation and recycle of water, cooling tower, spray pond.

3. Compressed air systems. Vacuum systems, boosters, air receivers, piping network, air leaks, and lubrication and oil removal.

4. Refrigeration systems and their characteristics, use of cryogenic temperatures.

5. Sir condition and ventilation systems and their characteristics, air water systems, introduction to humidification and dehumidification equipment's, air blending and exhaust.

6. Generation distribution and utilization of steam, steam economy and handling steam engines, boiler and performance characteristics.

Section B: Energy Management

Introduction: Energy sources, energy demand and supply, Energy crisis, future scenario; Energy system efficiency.

Energy Conversion Systems and Energy Conservation.

Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, planning and program, Matching energy use to requirement, Maximizing system efficiencies, Energy analysis and Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments. Design of Energy Efficient / Conservation Devices such as Distillation Coloumn, Waste Heat Boilers, Furnaces etc.

CHC 17104   **Modelling and Simulation**   **3-1-0**

Course content

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.

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.

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.

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.

ELECTIVE I (Any One)

CHE 17105   **Fluidization Engineering**   **3-0-0**

Phenomenon of fluidization; Fluidization regimes; Types of fluidization operations; Typical industrial applications of fluidized beds.

Gross behaviour of fluidized beds: Minimum fluidization velocity; Distributor and bubble formation;

Bed voidage; Transport disengaging height (TDH); Bulk viscosity, fluidity and power consumption.

Bubble behaviour and models of bubbling beds. Flow pattern of gas and solid in fluidized bed and freeboard region. Heat and mass transfer in fluidized bed. Entrainment and elutriation from fluidized bed.

Residence time distribution and size distribution of solids in fluidized bed.

Circulating fluidized bed; Pneumatic transport of solids. Design of fluidized bed for physical operations, catalytic reactions and non-catalytic reactions.

CHE 17106   **Polymer Science and Technology**   **3-0-0**

Classification of polymers: Natural and synthetic polymers; Thermosets and thermoplasts; Copolymers; Terpolymers; Degradable and non-degradable polymers.

Addition polymerization; Condensation polymerization; Ring opening polymerization; Copolymerization; Polymerization by coordination catalyst; Molecular weight distribution of polymers.

Manufacturing processes of important polymers: Plastics-polyethylene; polypropylene, polyvinyl   chloride and copolymers, polystyrene; phenol-formaldehyde, epoxides; urethane; teflon; Rubbers and elastomers; Fibres - cellulosic (rayon), polyamides (6;6 Nylon), polyesters (Dacron), acrylic;

Polymeric oils.

Micro-structure of polymer chains: Configuration and conformation; Simple and hindered rotation;

End-to-end distances; Crystallinity and melting; Glass transition temperature; Physical states of polymers and mode of motion of polymer chains; Measurement of viscosity; Cohesive energy density; Compatibility and solubility parameters; Polymer additives, blends and composites.

Flow properties of polymers: Bulk deformation, elongational and shear flow; Non-Newtonian flow.

Polymer fabrication techniques: Formation of flat sheets and films; Laminations; Foam formation; Extrusion, injection molding, blow molding, compression and transfer molding; Spinning of fibres

Mechanical properties of polymers: Rheology of polymers; Rubber elasticity; Visco-elasticity; Creep

and stress relaxation; Dynamic behavior; Stress and fracture of rubber and glassy polymers. Polymer degradation. Conducting polymers; Smart polymers.

Ecology and environmental aspects of polymer industries.

CHE 17107   Multicomponent Separation   3-0-0

Introduction to the Fundamentals of Distillation.

Multicomponent flash calculation

Isothermal flash calculation, Adiabatic flash calculation

Approximate methods for multicomponent multistage separation

Design methods and simulation methods for multistage contactor

Fenske Underwood Gilliland (FUG) method for distillation

Multistage counter-current cascade Group method for absorber and stripper

Rigorous method for multicomponent multistage separation

Introduction to MESH equation

Historical development of different rigorous multicomponent distillation calculation method.

Classification of different method based on solution scheme

Thiele Geddes method with theta () method of convergence

Wang and Henke tridiagonal matrix algorithm for complex distillation column

AC/CHE17108   Corrosion Engineering   3-0-0

Electrochemical and thermodynamic principles, Nernst equation and electrode potentials of metals, EMF and galvanic series, merits and demerits; origin of Pourbaix diagram and its importance to iron, aluminium and magnesium metals

Exchange current density, polarization - concentration, activation and resistance, Tafel equation; passivity, electrochemical behaviour of active/passive metals, Flade potential, theories of passivity

Atmospheric, pitting, dealloying, stress corrosion cracking, intergranular corrosion, corrosion fatigue, fretting corrosion and high temperature oxidation; causes and remedial measures

Purpose of testing, laboratory, semi-plant and field tests, susceptibility tests for IGC, stress corrosion cracking and pitting, sequential procedure for laboratory and on-site corrosion investigations, corrosion auditing and corrosion map of India

Corrosion prevention by design improvements, anodic and cathodic protection, metallic, non-metallic and inorganic coatings, mechanical and chemical methods and various corrosion inhibitors

MSC 17152   Industrial Engineering & Management   3-0-0

Basic functions of Management-Planning, organizing, staffing, directing and controlling.

Introduction to industrial Engineering techniques.

Productivity:definition, measurement.

Work study and its role in in improving productivity of an organization.

Types of production systems.

Introduction to production planning and control.

Concept of Human Resource Management-Selection, Training & Development.

Finance Management-Capital Budgeting Techniques, Pay- back period, ARR, NPV, IRR, PI; Sources of capital; Cost concepts and Break-even analysis.

Project Management- Introduction, Network construction & identification of critical activities in CPM & PERT.

CHC 17201   Process Simulation Lab   0-0-3

CHC 17211   Projects   0-0-6

Eight Semester

CHC 18101   Safety and Hazard analysis in Process Industry   3-1-0

Course content

Industrial safety, Industrial hygiene and safety aspects related to toxicity, noise, pressure, temperature,

vibrations, radiation etc. Explosions including dust , vapor, cloud and mist explosion.

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.

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.

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 relief's.

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

Occupational safety and Hazard.

ESE 18101   Industrial Process Control and Management   3-1-0

Course content

Ecology and Environment. sources of air, water and solid Wastes. Air Pollution : Micrometeorology and dispersion of pollutants in environment. Fate of pollutants. Air pollution control technologies; centrifugal collectors, electrostatics precipitators, bag filter and wet scrubbers. Design and efficiencies. Combustion generated pollution, vehicles emission control. Case studies. Water Polltion : Water quality modelling for streams. Characterisation of effluents, effluent standards. Treatment methods. Primary methods : Settling pH Control, Chemical Treatment. Secondary method : Biological Treatment. Tertial Treatment like, ozonisation, disinfection, etc. Solid waste collection, treatment and disposal. Waste recovery system. EIA rules & guidelines.

CHC 18102   Petroleum Refining and Petrochemicals   3-1-0

Course content

Genesis, occurrence, exploration and production of crude oil. Composition and

Evaluation of crude oil and testing of petroleum products.

Atmospheric and vacuum distillation. Pretreatment of crude oil and transportation.

Cracking processes - Thermal cracking, Vis-breaking, Coking. Catalytic cracking (FCC), Hydro cracking,

Rebuilding processes: Alkylation, Aromatization, Polymerization; Isomerisation; Reforming

Treatment Processes- Treatment techniques for removal of sulphur compounds to improve performance, Storage and stability. Product treatment processes - various solvent treatment processes, Dewaxing ,Clay treatment, hydro treatment and Hydro fining.

Feedstock of petrochemical industries; Developments of petrochemical industries in India and abroad; Cracking of naphtha and gas for the production of Olifines. Production of acetylene from methane Catalytic Reforming of petroleum feed stocks. Extraction of Aromatics.

Elective- II (Any One)

CHE 18103   Computer Aided Process Equipment design   [3-1-0]

Elements of computer-aided system design, Interactive methods, Computer graphics, Database technology, Algorithms.

Detailed Design of:

1. Vessels

2. Heat Exchangers

3. Distillation Column

4. Absorber

5. Evaporator

CHE 18104   Advanced Separation Technologies   [3-1-0]

Membrane Separation Process: Different types of membranes, module design, concentration polarization and other effects, characterization of membranes, process design

Classifications of different membrane separation processes: Pressure-driven membrane processes - microfiltration, ultrafiltration, nanofiltration and reverse Osmosis.

Other membrane separation processes: Dialysis, Electrodialysis, Pervaporation

Liquid membrane: Emulsion Liquid membrane, supported liquid membrane

New membrane separation processes like Membrane Distillation, Membrane Contactor and hybrid processes.

Dialysis and Ion-Exchange.

Chromatographic and electrophoresis separation, Desalination.

Micro Filtration, Ultra Filtration, Nano Filtration, Reverse Osmosis

CHE 18105   Advanced Process Dynamics and Control   [3-1-0]

Introduction to process dynamics and control. Response of first order systems in series, Higher order systems: Second order and transportation lag.

Feedback Controllers, Control System Instrumentation, Process Safety and Process Control, Dynamic Behavior and Stability of Closed-Loop Control Systems, PID Controller Design, Tuning, and Troubleshooting, Control Strategies at the Process Unit Level, Frequency Response Analysis and Control System Design, Feedforward and Ratio Control, Enhanced Single-Loop Control Strategies, Digital Sampling, Filtering, and Control, Multiloop and Multivariable Control, Real-Time Optimization, Model Predictive Control, Process Monitoring, Batch Process Control

PEC 16103   NATURAL GAS ENGINEERING   [3-1-0]

1. Gas from condensate and oilfields. Scope of Natural gas industry. Basic thermodynamic and system energy concepts in Natural Gas Engineering.

2. Physical properties of natural gas and hydrocarbon liquids associated with Natural gas. Reservoir aspects of natural gas.

3. Flow of fluids. Compression calculations. Heat Transfer and Mass Transfer principles and applications in Natural Gas Engineering.

4. Gas flow measurement. Process control and instrumentation in natural gas processing plants.

5. Natural Gas Processing. Field separation and oil absorption process. Refrigeration and low temperature processing. Liquefaction Process. Dehydration of Natural Gas sweetening of Natural gas and sulphur recovery, Processing for LPG, LNG, CNG, system.

6. Transmission of Natural Gas. Specifications. Utilization of Natural Gas. Underground storage and conservation of Natural Gas.

7. Unconventional gas: Coal Bed Methane, Natural Gas Hydrate. Insitu Coal Gasification.

8. Conversion of gas to liquid.

CHE 18106   Optimization Techniques   [3-1-0]

Introduction to process optimization; formulation of various process optimization problems and their classification. Basic concepts of optimization-convex and concave functions, necessary and sufficient conditions for stationary points.

Optimization of one dimensional functions, unconstrained multivariable optimization- direct search methods. Bracketing methods: Exhaustive search method, Bounding phase method Region elimination methods: Interval halving

method, Fibonacci search method, Golden section search method. Point-Estimation method: Successive quadratic estimation method. Indirect first order and second order method. Gradient-based methods: Newton-Raphson method, Bisection method, Secant method, Cubic search method. Root-finding using optimization techniques.

Multivariable Optimization Algorithms: Optimality criteria, Unidirectional search, direct search methods: Evolutionary optimization method, simplex search method, Powell's conjugate direction method. Gradient-based methods: Cauchy's (steepest descent) method, Newton's method.

Constrained Optimization Algorithms: Kuhn-Tucker conditions, Transformation methods: Penalty function method, method of multipliers, Sensitivity analysis, Direct search for constraint minimization: Variable elimination method, complex search method.

Successive linear and quadratic programming, optimization of staged and discrete processes. Specialized & Non-traditional Algorithms: Integer Programming: Penalty function method, Nontraditional Optimization Algorithms

Elective III (Any One)

CHE 18107   **Clean Coal Technology**   **[3-0-0]**

Coal Characteristics: Chemical Properties, Physical Properties and Plastic Properties.

Combustion: Conventional combustion appliances, Combustion stoichiometry, kinetics and thermodynamics of combustion.

Introduction to clean coal technology:

Precombustion coal cleaning methods including biological and chemical cleaning methods.

Clean coal combustion technology: AFBC, Circulating Fluidized Bed Combustion, Slagging combustion. Pressurized Fluidized Bed Combustion. SO_x and NO_x control strategies during combustion.

Post Combustion Technology for control of SOx, NOx and Particulate Matter

Coal gasification combined cycle method.

Coal Liquefaction

UCG, CBM, CWM/COM

CHE 18108   **Applied Catalysis**   **[3-0-0]**

Define a heterogeneous catalyst and describe its properties ; Describe the steps in a heterogeneous catalytic reaction ; Apply the concept of rate-limiting step to find a rate law ; Apply the design algorithm to isothermal heterogenous catalytic reactors; Describe different types of catalyst deactivation; Describe ways to deal with catalyst deactivation and when each should be used;

47

Incorporate catalyst deactivation into the design of isothermal catalytic reactors.

CHE 18109   Particulate Science and Technology   [3-0-0]

Characteristics of Particulate Material: Properties and characterisation of particulate solids, analysis and technical methods for size and surface area distribution of powder; Flow properties of particulates.

Synthesis Methods: Introduction to synthesis of composite material by spray technique, aerosol generation, Introduction to size reduction equipment, energy and power requirement in milling operations, computer simulation techniques for mill performance.

Particulate Processes: Gas-liquid separation methods, Classification by size, agitation of liquids and mixing of solids, Fluidization, encapsulation etc.

Handling of Particulate Materials: Conveying methods, Storage methods and design of silo, selection of feeders and elevators.

CHE 18110   Interfacial Science and Technology   [3-0-0]

Phenomenology of colloidal materials; Brownian diffusion; long range van der Waals forces;

double layer forces and short range forces; DLVO theory of stability of lyphobic colloids;

electro kinetic phenomena; association colloids; interfacial tension; wetting and contact angle;

capillary hydrostatics; interfacial rheology and stability; Applications of principles

of colloid and interface science in detergents, personal products, pharmaceuticals, food, textile,

paint and petroleum industries.

CHE 18111   Green Technologies   [3-0-0]

Introduction and concept of green power,

Different routes for green power generation through fossil fuels; FBC, ICGCC, UCG, CBM, Hybrid cycles, MHD.

Green power generation through non-conventional sources of energy and their importance in Indian context.

Cogeneration or Combined heat and power.

Carbon capture technologies, carbon sequestration

Energy storage

Rational and Efficient energy utilization.

CHC 18210   Projects   0-0-6