Chemical Engineering

B.TECH. PROGRAMME

Curricula for B.Tech. in Chemical Engineering

B.Tech (Chemical Engineering) - semester 1

S. No	Code	Course Title	L	T	P	Total	Credit
01	HMTS1101	Business English	2	0	0	2	2
02	PHYS1001	Physics-I	3	1	0	4	4
03	MATH1101	Mathematics-I	3	1	0	4	4
04	ECEN1001	Basic Electronics Engineering	3	1	0	4	4
05	MECH1101	Engineering Mechanics	3	1	0	4	4
Total							18

LABORATORY

S. No	Code	Course Title	L	T	P	Total	Credit
01	PHYS1011	Physics-I lab	0	0	3	3	2
02	ECEN1011	Basic Electronics Engineering Lab.	0	0	3	3	2
03	MECH1011	Workshop Practice	1	0	3	4	3
Total							7

SESSIONAL

S. No	Code	Course Title	L	T	P	Total	Credit
01	HMTS1111	Language Practice lab (Level 1)	0	0	2	2	1
02	HMTS1121	Co- Curricular activities	0	0	2	2	1
Total							2
TOTAL CREDIT							**27**

B.Tech (Chemical Engineering) - semester 2

S. No	Code	Course Title	L	T	P	H	Credit
01	CSEN 1201	Introduction to Computing	3	1	0	4	4
02	CHEM 1001	Chemistry- I	3	1	0	4	4
03	MATH 1201	Mathematics- II	3	1	0	4	4
04	ELEC 1001	Basic Electrical Engineering	3	1	0	4	4
05	MECH 1201	Engineering Thermodynamics and Fluid Mechanics	3	1	0	4	4
TOTAL							20

LABORATORY

S. No	Code	Course Title	L	T	P	H	Credit
01	CSEN 1211	Introduction to Computing Lab	0	0	3	3	2
02	CHEM 1011	Chemistry–I Lab	0	0	3	3	2
03	ELEC 1011	Basic Electrical Engineering Lab.	0	0	3	3	2
04	MECH 1012	Engineering Drawing	1	0	3	4	3
TOTAL							9
TOTAL CREDIT							**29**

B.Tech (Chemical Engineering) - semester 3

S. No	Code	Course Title	L	T	P	H	Credit
01	CHEN 2101	Mechanical Operation	3	1	0	4	4
02	CHEN 2102	Fluid Mechanics	3	1	0	4	4
03	CHEN 2103	Energy Engineering	3	1	0	4	4
04	CHEN 2104	Industrial Stoichiometry	3	1	0	4	4
05	CHEM 2001	Basic Environmental Engineering & Ecology	3	0	0	3	3
06	HMTS 2002	Indian Culture and Heritage	2	0	0	2	1
Total							20

LABORATORY

S. No	Code	Course Title	L	T	P	H	Credit
01	CHEN 2111	Energy lab	0	0	3	3	2
02	CHEN 2112	Fluid Mechanics Lab	0	0	3	3	2
03	CHEN 2113	Mechanical Operation Lab	0	0	3	3	2
04	CHEN 2114	Chemical Engineering Drawing Laboratory	0	0	3	3	2
Total							8
TOTAL CREDIT							**28**

B.Tech (Chemical Engineering) - semester 4

S. No	Code	Course Title	L	T	P	H	Credit
01	HMTS 2001	Human values and Professional Ethics	2	0	0	2	2
02	CHEM 2201	Chemistry -II	3	0	0	3	3
03	CSEN 2201	Data Structure and Database Concept	3	1	0	4	4
04	CHEN 2201	Process Heat Transfer	3	1	0	4	4
05	CHEN 2202	Separation Process - I	3	1	0	4	4
06	CHEN 2203	Chemical Engineering Thermodynamics	3	1	0	4	4
Total							21

LABORATORY

S. No	Code	Course Title	L	T	P	H	Credit
01	CSEN 2211	DBMS lab	0	0	3	3	2
02	CHEN 2211	Heat Transfer lab	0	0	3	3	2
03	HMTS 2011	Language Practice Lab (Level 2)	0	0	3	3	2
Total							6
TOTAL CREDIT							**27**

B.Tech (Chemical Engineering) - semester 5

S. No	Code	Course Title	L	T	P	H	Credit
01	HMTS 3101	Economics for Engineers	3	0	0	3	3
02	CHEN 3101	Chemical Process Technology-I	3	0	0	3	3
03	CHEN 3102	Chemical Reaction Engineering	3	1	0	4	4
04	CHEN 3103	Separation Process - II	3	1	0	4	4
05	CHEN 3104	Numerical Methods of Analysis	3	1	0	4	4
06	CHEN 3131 to 3133	Departmental Elective-I	3	0	0	3	3
Total							21

LABORATORY

S. No	Code	Course Title	L	T	P	H	Credit
01	CHEN 3111	Mass Transfer laboratory	0	0	3	3	2
02	CHEN 3112	PEDD- I	0	0	4	4	3
03	CHEN 3113	Chemical Reaction Engineering Laboratory	0	0	3	3	2
Total							7
TOTAL CREDIT							**28**

B.Tech (Chemical Engineering) - semester 6

S. No	Code	Course Title	L	T	P	H	Credit
01	CHEN 3201	Process Dynamics, Instrumentation and Control	3	1	0	4	4
02	CHEN 3202	Project Engineering	3	0	0	3	3
03	CHEN 3203	Chemical Process Technology II	3	0	0	3	3
04	CHEN 3204	Mathematical Methods in Chemical Engineering	3	1	0	4	4
05	CHEN 3231to 3233	Departmental Elective-II	3	0	0	3	3
06	HMTS 3201	Principles of Management	2	0	0	2	2
Total							19

LABORATORY

S. No	Code	Course Title	L	T	P	H	Credit
01	CHEN 3211	PEDD- II	0	0	4	4	3
02	CHEN 3212	Numerical Methods Laboratory	0	0	3	3	2
Total							5
TOTAL CREDIT							24

SESSIONAL

S. No.	Code	Course Title	L	T	P	H	Credit
01	HMTS 3221	Personality Development	0	0	1	1	1
		Seminar I					2
TOTAL CREDIT							**27**

List of Departmental Electives of 5th & 6th Semeter :-

Departmental Elective (CHEN 3131 to 3133)	Departmental Elective II (CHEN 3231 to 3233)
CHEN 3131 Polymer Science & Engineering	CHEN 3231 Nano Technology
CHEN 3132 Petrochemical Technology	CHEN 3232 Computational Fluid Dynamics
CHEN 3133 Material Science & Engineering	CHEN 3233 Bioprocess Engineering

B.Tech (Chemical Engineering) - semester 7

S. No	Code	Course Title	L	T	P	H	Credit
01	CHEN 4101	Transport Phenomena	3	1	0	4	4
02	CHEN 4103	Modeling Simulation & optimization	3	0	0	3	3
03	CHEN 4131to 4133	Departmental Elective –III	3	0	0	3	3
04	FE 4101	Free Elective-I	3	0	0	3	3
Total							13

LABORATORY

S. No	Code	Course Title	L	T	P	H	Credit
01	CHEN 4111	Project –I	0	0	6	6	4
02	CHEN 4112	Instrumental Methods of Analysis Lab	0	0	3	3	2
03	CHEN 4113	Process Control Laboratory	0	0	3	3	2
Total							8

SESSIONAL

S. No	Code	Course Title	L	T	P	H	Credit
01	CHEN 4121	Industrial Training					2
02	CHEN 4122	Seminar II					2
03	HMTS 4121	Group discussion for Professionals			3	3	2
Total							6
TOTAL CREDIT							**27**

B.Tech (Chemical Engineering) - semester 8

S. No	Code	Course Title	L	T	P	H	Credit
01	CHEN 4231to 4233	Departmental Elective- IV	3	0	0	3	3
02	FE 4202	Free Elective-II	3	0	0	3	3
03	HMTS 4204	Operation Research	2	0	0	2	2
Total							8

LABORATORY

S. No	Code	Course Title	L	T	P	H	Credit
01	CHEN 4211	Project –II	0	0	8	8	8
Total							8

SESSIONAL

S. No	Code	Course Title	L	T	P	H	Credit
01	CHEN 4221	Plant Design					4
02	CHEN 4222	Comprehensive Viva Voce					3
Total							7
TOTAL CREDIT							**23**

List of Departmental Electives:-

Departmental Elective(CHEN3131 to 3133)	**Departmental Elective II (CHEN 3231 to 3233)**	**Departmental Elective III (CHEN4131 to 4133)**	**Departmental Elective IV (CHEN 4231 to 4233)**
CHEN 3131 Polymer Science & Engineering	CHEN 3231 Nano Technology	CHEN 4131 Reactor Design	CHEN 4231 Catalysis & Catalytic Reactor Design
CHEN 3132 Petrochemical Technology	CHEN 3232 Computational Fluid Dynamics	CHEN 4132 Industrial Safety & Hazard Analysis	CHEN 4232 Total Quality Management
CHEN 3133 Material Science & Engineering	CHEN 3233 Bioprocess Engineering	CHEN 4133 Advanced Separation Process	CHEN 4233 Environmental Engineering & pollution control.

List of Free Electives offered by Chemical Engineering Department :-

Free Elective (7th Semester)	***Free Elective (8th Semester)***
CHEN 4171 **Safety and Hazard Analysis**	**CHEN 4281** **Catalytic Reactor Design**
CHEN 4172 **Project Management**	**CHEN 4282** **Total Quality Management & Assurance**

List of Free Electives for Chemical Engineering students

Free Elective I (7th Semester)		**Free Elective II (8th Semester)**	
Paper Code	**Title of the papaer**	**Paper Code**	**Title of the Paper**
BIOT 4172	Bioploymers	BIOT 4282	Computational Biology
AEIE 4141	Instrumentation & Telemetry	AEIE 4232	Control System and Applications
ELEC 4192	Non-Conventional Energy	MATH 4201	Advanced Graph Theory
MATH 4102	Probability and Stochastic Processes	CIVIL 4280	Environmental Impact Assessment

	Credit Point in									
Paper Name	1st Sem	2nd Sem	3rd Sem	4th Sem	5th Sem	6th Sem	7th Sem	8th Sem	Total Credit	HIT Proposed Credit Point
BS	10	10	0	3	4	6	0	0	33	30-38
ES	13	19	3	6	0	0	0	0	41	30-40
HMTS	4	0	1	4	3	3	2	2	19	19
PC	0	0	24	14	18	13	11	4	84	60-80
DE	0	0	0	0	3	3	3	3	12	12-20
FE	0	0	0	0	0	0	3	3	6	6
Project	0	0	0	0	0	0	4	8	12	12
Seminar	0	0	0	0	0	2	2	0	4	4
Viva	0	0	0	0	0	0	0	3	3	3
Training	0	0	0	0	0	0	2	0	2	2
Total Credit	27	29	28	27	28	27	27	23	216	

	1st Sem	2nd Sem	3rd Sem	4th Sem	5th Sem	6th Sem	7th Sem	8th Sem	Total
Total Credit	27	29	28	27	28	27	27	23	216
Total Contact Hours	32	33	33	30	31	27	28	16	230

Course Name : BUSINESS ENGLISH					
Course Code: HMTS1101					
Contact hrs per week:	L	T	P	Total	Credit points
	2	0	0	2	2

Module I – [5L]

Communication Skill
Definition, nature & attributes of Communication
Process of Communication
Models or Theories of Communication
Types of Communication
Levels or Channels of Communication
Barriers to Communication

Module II-[12L]

Business Communication- Scope & Importance
Writing Formal Business Letters
Writing Reports
Organizational Communication: Agenda & minutes of a meeting, notice, memo, circular
Project Proposal
Technical Report Writing
Organizing e-mail messages
E-mail etiquette
Tips for e-mail effectiveness

Module III-[10L]

Language through Literature
Modes of literary & non-literary expression
Introduction to Fiction, (An Astrologer's Day by R.K. Narayan and Monkey's Paw by W.W. Jacobs), Drama (The Two Executioners by Fernando Arrabal) or (Lithuania by Rupert Brooke) & Poetry (Night of the Scorpion by Nissim Ezekiel and Palanquin Bearers by Sarojini Naidu)

Module IV-[3L]

Grammar in usage (nouns, verbs, adjectives, adverbs, tense, prepositions, voice change) -to be dealt with the help of the given texts.

References

1. Armand Matterlart and Michele Matterlart, Theories of Communication: A Short Introduction, Sage Publications Ltd., 1998.

2. Chan, Janis Fisher, and Diane Lutovich. Professional Writing Skills. San Anselmo, CA:
   Advanced Communication Designs, 1997.

3. Geffner, Andrew P. Business English. Hauppauge, New York: Barron's Educational Series, 1998.

4. Good, Edward C. Mightier Than the Sword. Charlottesville: Word Stone Publications, 1989.

5. Edward P.Bailey, Writing and Speaking at Work: A Practical Guide for Business Communication, Prentice-Hall, 7th edn, 2004.

6. Kitty O. Locker, Business and Administrative Communication, McGraw-Hill/ Irwin, 7th edn, 2004.

7. Lillian Chaney and Jeanette Martin, Intercultural Business Communication, Prentice Hall, 4th edn, 2005.

8. Yudkin, Marcia. Persuading on Course Name. Lansing, IL: Infinity Publishing, 2001.

Course Name : Chemistry 1					
Course Code: CHEM 1001					
Contact hrs per week:	L	T	P	Total	Credit points
	3	1	0	4	4

Module I [10 L]

Thermodynamics & Spectroscopy

Chemical Thermodynamics & Thermochemistry

Concept of Thermodynamic system, Introduction to first law of thermodynamics, Enthalpy Heat Capacity, Reversible and Irreversible processes, Adiabatic changes, Application of first law of thermodynamics to chemical processes, 2nd law of thermodynamics, Evaluation of entropy, Work function and free energy, Phase Changes, Clausius Clapeyron Equation, Chemical Potential, Gibbs Duhem Relation, Activity and Activity coefficient.

Spectroscopy

Electromagnetic Radiation, Basic idea of UV-visible & IR spectroscopy.

Module II [10 L]

Structure & Bonding

Chemical Bonding

Covalent bond, VSEPR Theory, Molecular Orbital Theory, Hydrogen bond, Intermolecular forces-vander Waals forces, Ionization energy, Electronegativity, Electron affinity, Hybridisation, Dipole moment

Solid State Chemistry

Introduction to stoichiometric defects (Schottky & Frenkel) and non – stoichiometric defects (Metal excess and metal deficiency). Role of silicon and germanium in the field of semiconductor.

Ionic Equilibria and Redox Equlibria

Acid Base Equilibria in water, Strength of acids and bases, Hydrogen ion exponent, Ionic product of water, Salt Hydrolysis and Henderson Equation, Buffer solutions, pH indicator, Common ion Effect, Solubility product, Fractional Precipitation, Redox Equilibria,

Structure and reactivity of Organic molecule

Inductive effect, resonance, hyperconjugation, electromeric effect, carbocation, carbanion and free radicals.
Brief study of some addition, eliminations and substitution reactions.

Module III [10 L]

Electrochemistry & Reaction Dynamics

Conductance

Conductance of electrolytic solutions, specific conductance, equivalent conductance, molar conductance, ion conductance, effect of temperature and concentration (Strong and Weak electrolyte). Kohlrausch's law of independent migration of ions, transport numbers and hydration of ions. Conductometric titrations: SA vs SB & SA vs WB; precipitation titration KCl vs $AgNO_3$.

Electrochemical Cell

Cell EMF and thermodynamic derivation of the EMF of a Galvanic cell (Nernst equation), single electrode potentials, hydrogen half-cell and calomel half cell (construction, representation, cell reaction, expression of potential, discussion, application) Storage cell, fuel cell (construction, representation, cell reaction, expression of potential, discussion, application). Application of EMF measurement on a) the change in thermodynamic function (ΔG, ΔH, ΔS) b) the equilibrium constant of a reversible chemical reaction c) the valency of an ion.

Kinetics

Reaction laws: rate expression, order and molecularity, zero, first and second order kinetics. Pseudounimolecular reaction, Arrhenius equation.
Mechanism and theories of reaction rates (Collision theory and Transition state theory,).
Catalysis: Homogeneous catalysis (Definition, example, mechanism, kinetics).

Module IV [10 L]

INDUSTRIAL CHEMISTRY & POLYMERIZATION

Industrial Chemistry

Solid Fuel: Coal, Classification of coal, constituents of coal, carbonization of coal (HTC and LTC), Coal analysis: Proximate and ultimate analysis.
Liquid fuel: Petroleum, classification of petroleum, Refining, Petroleum distillation, Thermal cracking, Octane number, Cetane number, Aviation Fuel (Aviation Gasoline, Jet Gasoline), Bio-diesel.
Gaseous fuels: Natural gas, water gas, coal gas, bio gas.

Polymerization

Concepts, classifications and industrial applications. Polymer molecular weight (number avg. weight avg. viscosity avg.: Theory and mathematical expression only), Poly dispersity index (PDI). Polymerization processes (addition and condensation polymerization), degree of polymerization, Copolymerization, stereo-regularity of polymer, crystallinity (concept of T_m) and amorphicity (Concept of T_g) of polymer.

Preparation, structure and use of some common polymers: plastic (PE: HDPE, LDPE, PVC, Bakelite, PP), rubber (natural rubber, SBR, NBR) and Vulcanization., fibre(nylon 6.6, Nylon 6, Polyester).
Conducting and semi-conducting polymers.

Text Books

1. Engineering Chemistry, Gourkrishna Dasmohapatra, Vikas Publishing House
2. A Text book of Engineering Chemistry, Shashi Chawla, Dhanpat Rai & Co Pvt Ltd
3. Engineering Chemistry, K. L. Chugh, Kalyani Publishers.

Reference Books

1. General & Inorganic Chemistry, R. P. Sarkar, Fuels and Combustion, New Central Book Agency P Ltd
2. L. Finar, Organic Chemistry, Addison Wesley Longman, Inc
3. Organic Chemistry, Morrison & Boyd, Prentice Hall of India
4. Physical Chemistry, K. L. Kapoor, McMillan
5. P. C. Rakshit, Physical Chemistry, Sarat Book House (7th Edition).

Course Name : MATHEMATICS I					
Course Code: MATH1101					
Contact hrs per week:	L	T	P	Total	Credit points
	3	1	0	4	4

Module I [10L]

Matrix:

Matrices and their basic attributes, Determinant of a square matrix, Minors and Cofactors, Laplace's method of expansion of a determinant, Product of two determinants, Adjoint of a determinant, Jacobi's theorem on adjoint determinant. Singular and non-singular matrices, Adjoint of a matrix, Inverse of a non-singular matrix and its properties, Orthogonal matrix and its properties, Special Complex Matrices: Hermitian, Unitary, Normal(definition only), Rank of a matrix and its determination using elementary row and column operations, Solution of simultaneous linear equations by :Cramer's Rule and Matrix inversion method, Consistency and inconsistency of a system of homogeneous and inhomogeneous linear simultaneous equations, Characteristic Equation and computation of eigenvalues and eigenvectors of a square matrix (of order 2 or 3), Cayley-Hamilton theorem and its applications(with special reference to higher power of matrices, e.g. Idempotent and Nilpotent matrices)

Module II [10 L]

Mean Value Theorems & Expansion of Functions:

Rolle's theorem: its geometrical interpretation and its application, Concavity and Convexity of curves, Mean Value theorems – Lagrange & Cauchy and their application, Taylor's theorem with Lagrange's and Cauchy's form of remainders and its application, Expansions of functions by Taylor's and Maclaurin's theorem, Maclaurin's infinite series expansion of the functions: $\sin x, \cos x, e^x, \log(1+x), (a+x)^n, n$ being an integer or a fraction (assuming that the remainder $R_n \to 0$ as $n \to \infty$ in each case).

Infinite Series:

Preliminary ideas of sequence, Infinite series and their convergence/divergence, Infinite series of positive terms, Tests for convergence: Comparison test, Cauchy's Root test, D' Alembert's Ratio test(statements and related problems on these tests), Raabe's test, Proof of e being irrational, Alternating series, Leibnitz's Test (statement, definition) illustrated by simple examples, Absolute convergence and Conditional convergence,

Module III [10 L]

Successive differentiation:

Higher order derivatives of a function of single variable, Leibnitz's theorem (statement only and its application, problems of the type of recurrence relations in derivatives of different orders and also to find $(y_n)_0$).

Calculus of Functions of Several Variables:

Recapitulation of some basic ideas of limit and continuity of functions of single variable, Introduction to functions of several variables with examples, Knowledge of limit and continuity, Determination of partial derivatives of higher orders with examples, Homogeneous functions and Euler's theorem and related problems up to three variables, Chain rules, Differentiation of implicit functions, Total differentials and their related problems, Jacobians up to three variables and related problems, Maxima, minima and saddle points of functions and related problems.

Module-IV [10 L]

Multiple Integration and Vector Calculus:

Concept of line integrals, Double and triple integrals. Vector function of a scalar variable, Differentiation of a vector function, Scalar and vector point functions, Gradient of a scalar point function, divergence and curl of a vector point function, Directional derivative, Related problems on these topics, Green's theorem, Gauss Divergence Theorem and Stoke's theorem (Statements and applications).

Reduction formula:

Reduction formulae both for indefinite and definite integrals of types:

$\int \sin^n x, \int \cos^n x, \int \sin^m x \cos^n x, \int \cos^m x \sin nx, \int \frac{dx}{(x^2+a^2)^n}, m, n$ are positive integers.

References

1. Advanced Engineering Mathematics: Erwin Kreyszig by Wiley India
2. Engineering Mathematics: B.S. Grewal (S. Chand & Co.)
3. Higher Engineering Mathematics: John Bird (Elsevier)
4. Advanced Engineering Mathematics: Wiley and Barrett (Tata McGraw-Hill)
5. Calculus: M. J. Strauss, G. L. Bradley and K. L. Smith (Pearson Education)
6. Engineering Mathematics: S. S. Sastry (PHI)
7. Advanced Engineering Mathematics: M.C. Potter, J.L. Goldberg and E.F. Abonfadel (OUP),Indian Edition.
8. Linear Algebra(Schaum's outline series): Seymour Lipschutz, Marc Lipson (McGraw Hill Education)
9. Vector Analysis(Schaum's outline series): M.R. Spiegel, Seymour Lipschutz, Dennis Spellman (McGraw Hill Education)
10. Introduction to Real Analysis: S.K.Mapa (Sarat Book Distributors)

Course Name : BASIC ELECTRICAL ENGINEERING					
Course Code: ELEC1001					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Module-I: [12 L]

DC Network Theorem: Kirchhoff's law, nodal analysis, mesh analysis, Superposition theorem, Thevenin's theorem, Norton theorem, Maximum power transfer theorem, star-delta conversion.

DC Machines: Construction, EMF equation, Principle of operation of DC generator, open circuit characteristics, external characteristics, Principle of operation of DC motor, Speed-torque characteristics of shunt and series machine, starting of DC motor, speed control of dc motor.

Module-II [8L]

Electrostatics: Gauss's law and its applications to electric field and potential calculation. Capacitor, capacitance of parallel plate capacitor, spherical capacitor and cylindrical capacitor.

Electromagnetism: Amperes law, Biot-savart's law, Ampere's circuital law and their applications, Magnetic circuits, analogy between magnetic and electric circuits, Faraday's law, self and mutual inductance. Energy stored in a magnetic field, Hysteresis and Eddy current losses.

Module-III [10L]

AC single phase system: concept of alternating signal, average and RMS values of alternating signal, peak factor, form factor, phase and phase difference, phasor representation of alternating quantities, phasor diagram, AC series , parallel and series parallel circuits, Active power, Reactive power, power factor, Resonance in RLC series and parallel circuit, Q factor, bandwidth.

Three phase system: balanced three phase system, delta and star connection, relationship between line and phase quantities, phasor diagrams. Power measurement by two wattmeter method.

Module-IV [10L]

Single phase transformer: Construction, EMF equation, no load and on load operation and their phasor diagrams, Equivalent circuit, Regulation, losses of a transformer, open and short circuit tests, efficiency.

3-phase induction motor: Concept of rotating magnetic field, principle of operation, Construction, equivalent circuit and phasor diagram, torque-speed/slip characteristics, Starting of Induction Motor.

Text Books:

1. Basic Electrical engineering, D.P Kothari & I.J Nagrath, TMH, Second Edition
2. Basic Electrical Engineering, V.N Mittle & Arvind Mittal, TMH, Second Edition
3. Basic Electrical Engineering, Hughes
4. Electrical Technology, Vol-I,Vol-II,Surinder Pal Bali, Pearson Publication
5. A Text Book of Electrical Technology, Vol. I & II, B.L. Theraja, A.K. Theraja, S.Chand &
Company

Reference Books:

1. Electrical Engineering Fundamentals, Vincent Del Toro, Prentice-Hall
2. Advance Electrical Technology, H.Cotton, Reem Publication
3. Basic Electrical Engineering, R.A. Natarajan, P.R. Babu, Sictech Publishers
4. Basic Electrical Engineering, N.K. Mondal, Dhanpat Rai
5. Basic Electrical Engineering, Nath & Chakraborti
6. Fundamental of Electrical Engineering, Rajendra Prasad, PHI, Edition 2005.

Course Name : ENGINEERING MECHANICS					
Course Code: MECH 1101					
Contact hrs per week:	L	T	P	Total	Credit points
	3	1	0	4	4

Module-I [10L]

Importance of Mechanics in Engineering ; Definition of Mechanics; Concepts of particles & rigid bodies;

Vector and scalar quantities; Vector algebra –definition and notation; Types of vectors – equal , equivalent , free , bound , sliding ; Addition , subtraction of vectors ; Parallelogram law , triangle law , vector polygon ; Scalar multiplication of vectors ; Resolution of vectors in Cartesian co–ordinate system ; Unit vector, unit co–ordinate vectors ($\hat{i}$, $\hat{j}$, $\hat{k}$) ; Direction cosines ; Addition/ subtraction of vectors in components form.

Definition of force vector ; Dot product , cross product and the application ; Important vector quantities (position vector , displacement vector) ; Moment of a force about a point and about an axis , moment of a couple ; Representation of force and moments in items of $\hat{i}$, $\hat{j}$, $\hat{k}$. Principle of transmissibility of force (sliding vector); Varignon's theorem for a system of concurrent forces with proof; Resolution of a force by its equivalent force-couple system; Resultant of forces.

Module-II [10L]

Type of forces – collinear, concurrent, parallel, concentrated, distributed; Active and reactive forces, different types of reaction forces; Free body concept and diagram; Concept and equilibrium of forces in two dimensions; Equations of equilibrium; Equilibrium of three concurrent forces -- Lami's theorem.

Concept of friction: Laws of Coulomb's friction; Angle of friction, angle of repose, coefficient of friction -- static and kinematic.

Module-III [12L]

Distributed force system; Centre of gravity; Centre of mass & centroid; Centroid of an arc; Centroid of plane areas – triangle, circular sector, quadrilateral and composite area consisting of above figures.

Area moment of inertia: Moment of inertia of a plane figure; Polar moment of inertia of a plane figure; Parallel axes theorem.

Concept of simple stress and strain ; Normal stress , shear stress , normal strain, shear strain; Hooke's law; Poisson's ratio; stress- strain diagram of ductile and brittle material; Proportional limit, elastic limit, yield point , ultimate stress, breaking point; Modulus of elasticity.

Module-III [16L]

Introduction to dynamics: Kinematics & kinetics; Newton's laws of motion; Law of gravitation and acceleration due to gravity; Rectilinear motion of particles with uniform & non – uniform acceleration.
Plane curvilinear motion of particles: Rectangular components (projectile motion), normal and tangential components.
Kinetics of particles: D'Alembert's principle and free body diagram; Principle of work & energy; Principle of conservation of energy.
Impulse momentum theory: Conservation of linear momentum

References:

1. Engineering Mechanics:- Statics and Dynamics by Meriam & Kreige , Wiley india

2. Engineering Mechanics:- Statics and Dynamics by I.H. Shames, P H I

3. Engineering Mechanics by Timoshenko , Young and Rao , TMH

4. Element of strength of materials by Timoshenko & Young, E W P

5. Fundamentals of Engineering Mechanics by Nag & Chanda – Chhaya Prakashani.

Course Name : CHEMISTRY I LAB					
Course Code: CHEM 1011					
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	3	3	2

List of Experiments:

1. To determine the alkalinity in a given water sample.
2. Estimation of iron using $KMnO_4$: self indicator.
3. Estimation of iron using $K_2Cr_2O_7$: redox sensitive indicator.
4. To determine total hardness and amount of calcium and magnesium separately in a given water sample.
5. To determine the value of the rate constant for the hydrolysis of ethyl acetate catalyzed by hydrochloric acid.
6. Heterogeneous equilibrium (determination of partition coefficient of acetic acid between n-butanol and water).
7. Conductometric titration for determination of the strength of a given HCl solution by titration against a standard NaOH solution.
8. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
9. Iodometric estimation of Cu^{2+}.
10. To determine chloride ion in a given water sample by Argentometric method (using chromate indicator solution)

Course Name : BASIC ELECTRICAL ENGINEERING LAB.					
Course Code: ELEC1011					
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	3	3	2

List of Experiments:

1. Characteristics of Fluorescent lamps
2. Characteristics of Tungsten and Carbon filament lamps
3. Verification of Thevenin's & Norton's theorem.
4. Verification of Superposition theorem
5. Verification of Maximum Power Transfer theorem
6. Calibration of ammeter and voltmeter.
7. Open circuit and Short circuit test of a single phase Transformer.
8. Study of R-L-C Series / Parallel circuit
9. Starting and reversing of speed of a D.C. shunt Motor
10. Speed control of DC shunt motor.
11. No load characteristics of D.C shunt Generators
12. Measurement of power in a three phase circuit by two wattmeter method.

Course Name : Engineering Drawing					
Course Code: MECH 1012					
Contact hrs per week:	L	T	P	Total	Credit points
	1	0	3	4	3

1. Importance of engineering drawing; Acquaintance with different drafting equipment & accessories;
2. Introduction to lines : Practising different types of lines; Basic concepts in Lettering : Practising vertical & inclined letters (Practice Sheet 1)
3. Different systems of dimensioning with practice.Introduction to the concept of scale of drawing. (Practice Sheet 2)
4. Introduction to concept of orthographic projection: 1st angle and 3rd angle projection method; Symbols; projection of points. (Practice Sheet 3)
5. Projection of straight lines for different orientation including inclined to both the planes. (Practice Sheet 4)
6. Projection of plane surfaces inclined to HP and parallel to VP; Inclined to VP and Parallel to HP (Practice Sheet 5)
7. Projection of solids: Cube, rectangular prism, Hexagonal prism, Cylinder, Pyramid, Cone. (Practice Sheet 6)
8. Section of solids and their projections on principal and auxiliary planes for true shape: Cylinder, hexagonal pyramid. (Practice Sheet 7)
9. Isometric projections: Basic concepts, isometric scale; Isometric projection and view.
10. Practice with simple laminar and solid objects. (Practice Sheet 8)

References:

1. “Elementary Engineering Drawing” by Bhatt, N.D; Charotan Book Stall, Anand
2. “Engineering Graphics” by Narayana, K.L. and Kannaaiah P; TMH
3. “Engineering Graphics” by Lakshminarayanan, V. and Vaish Wanar, R.S, JainBrothers.

Course Name : Language Practice Lab (level 1)					
Course Code: HMTS 1111					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**2**	**2**	**1**

Module I [3P]

Introduction to Linguistics (Phonology)
Phonetics-Vowel and Consonant Sounds (Identification &articulation)
Word- stress
Intonation (Falling and rising tone)
Voice Modulation
Accent training

Module II [3P]

Listening Skills
Principles of Listening
Approaches to listening
Guidelines for Effective Listening
Listening Comprehension
Audio Visual (Reviews)

Module III [2P]

Discourse Analysis-
Spoken Discourse
Conversational Skills/Spoken Skills
Analysing Speech dynamics
(Political Speeches
Formal Business Speeches)

Module IV [9P]

Writing Skill-
Descriptive, narrative and expository writing
Writing with a purpose---Convincing skill, argumentative skill/negotiating Skill (These skills will be repeated in oral skills).
Writing reports/essays/articles—logical organization of thoughts
Book review

References

1. Munter, Mary. Guide to Managerial Communication. 5th ed. Upper Saddle River, NJ: Prentice Hall, 1999.
2. Cypres, Linda. Let's Speak Business English. Hauppauge, NY: Barron's Educational Series, 1999. Crystal, David. 1971. *Linguistics.* Baltimore: Penguin Books.
3. Larsen-Freeman, D. (1986). "Techniques and principles in language teaching." Oxford: Oxford University Press.
4. Littlewood, W. (1981). "Language teaching. An introduction." Cambridge: Cambridge University Press.
5. Savignon, S. J., & Berns, M. S. (Eds.). (1983). "Communicative language teaching: Where are we going? Studies in Language Learning," 4(2). (EDRS No. ED 278 226, 210 pages)

Course Name : Co Curricular Activities					
Course Code: HMTS 1121					
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	2	2	1

Objective: This course aims at instilling a sense of social responsibility. This objective can be achieved by bringing in awareness about the contemporary issues relevant to the GenX and Gen Y through enlightened discussions and active participation. Since the course has 1 credit detailed planning regarding the area of activities and method of evaluation should be charted at the start of the semester.

Module I:

Project Work
Development of projects based on integral and holistic developmental models to be implemented in rural areas or underdeveloped areas in the peripheral areas of cities. This could include a wide area of activity –
from taking up a research projects to analyse the need of a particular under-developed area to trying to implement a project already formulated. This could also relate to mobilizing funds for a specific project.

Module II:

Action-oriented schemes

e.g.Organising Blood –donation camps
Conducting child –healthcare services
Helping the old and sick
(in coordination with NGOs and other institutes)

Module III:

Society and Youth

Developing Awareness among the youth about social issues both local and global for e.g. Eradication of social evils like drug abuse, violence against women and others.

Module IV:

Youth and Culture

Generating new ideas and help the participants to be creative and innovative for e.g.Enacting street plays, encouraging creative writing by organizing workshops and competitions. Active participation of the students in the nation building process by making positive changes in the social and individual space.

Course Name : Introduction to Computing					
Course Code: CSEN 1201					
Contact hrs per week:	L	T	P	Total	Credit points
	3	1	0	4	4

Learning Objective: Introduction to the concept of computer and computation and solving of problems using C as a programming language. Coverage of C will include basic concepts, arithmetic and logic, flow control, and data handling using arrays, structures, pointers and files.

Module I: [13L]

Fundamentals of Computer

History of Computers, Generations of Computers, Classification of Computers.

Basic Anatomy of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices. Assembly language, high level language, compiler and assembler (basic concepts).

Binary & Allied number systems (decimal, octal and hexadecimal) with signed and unsigned numbers (using 1's and 2's complement) - their representation, conversion and arithmetic operations. Packed and unpacked BCD system, ASCII. IEEE-754 floating point representation (half- 16 bit, full- 32 bit, double- 64 bit). Binary Arithmetic & logic gates. Boolean algebra – expression, simplification, Karnaugh Maps.

Basic concepts of operating systems like MS WINDOW, LINUX. How to write algorithms & draw flow charts.

Module II: [5L]

Basic Concepts of C

C Fundamentals:

The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements.

Operators & Expressions:

Arithmetic operators, relational and logical operators, type, conversion, increment and decrement operators, bit wise operators, assignment operators and expressions, precedence and order of evaluation. Standard input and output, formatted output -- printf, formatted input scanf.

Module III: [8L]

Program Structures in C

Flow of Control:

Statement and blocks, if-else, switch-case, loops (while, for, do-while), break and continue, go to and labels.

Basic of functions, function prototypes, functions returning values, functions not returning values. Storage classes - auto, external, static and register variables – comparison between them. Scope, longevity and visibility of variables.

C preprocessor (macro, header files), command line arguments.

Module IV: [14L]

Data Handling in C

Arrays and Pointers:

One dimensional arrays, pointers and functions – call by value and call by reference, array of arrays. Dynamic memory usage– using malloc(), calloc(), free(), realloc(). Array pointer duality.

String and character arrays; C library string functions and their use.

User defined data types and files:

Basic of structures; structures and functions; arrays of structures.

Files – text files only, modes of operation. File related functions – fopen(), fclose(), fscanf(), fprintf(), fgets(), fputs();

Text Books

1. Schaum's outline of Programming with C – Byron Gottfried
2. Teach Yourself C- Herbert Schildt
3. Programming in ANSI C – E Balagurusamy

Reference Books

1. C: The Complete Reference – Herbert Schildt
2. The C Programming Language- D.M.Ritchie, B.W. Kernighan

Course Name : PHYSICS 1					
Course Code: PHYS 1001					
Contact hrs per week:	L	T	P	Total	Credit points
	3	1	0	4	4

Module I: [22 L]

Optics

1.Interference :

The principle of superposition of waves, Superposition of waves: Two beam superposition, Multiple-beam superposition, coherent and incoherent superposition. Two source interference pattern (Young's double slit), Intensity distribution. Interference in thin films, wedge shaped films and Newton's rings, applications of interference. Newton's rings: Determination of wavelength of light, refractive index of liquid.

2 Diffraction:

Diffraction of light waves at some simple obstacles. Fraunhoffer diffraction through double slit and diffraction grating, grating spectra, resolving power of grating.

3. Polarisation & Fibre Optics:

Elementary features of polarization of light waves.Production and analysis of linearly, elliptic and Circularly polarized light, polaroids and application of polarizations. fibre optics - principle of operation, numerical aperture, acceptance angle

4 Laser

Characteristics of Lasers, Spontaneous and Stimulated Emission of Radiation, Meta-stable State, Population Inversion, Lasing Action, Einstein's Coefficients and Relation between them, Ruby Laser, Helium-Neon Laser, Semiconductor Diode Laser, Applications of Lasers.

Module II : [8L]

Waves & Oscillation

Superposition of two linear SHMs (with same frequency), Lissajous' figures. Damped vibration – differential equation and its solution, Critical damping, Logarithmic decrement, Analogy with electric circuits. Forced vibration – differential equation and solution, Amplitude and Velocity resonance, Sharpness of resonance and Quality factor. Progressive wave- Wave equation and its differential form, Difference between elastic (mechanical) and electromagnetic waves.

Module III : [9L]

Quantum Mechanics

Need for Quantum physics-Historical overviews, Particle aspects of radiation-Black body radiation, Compton scattering, pair production., Origin of X-ray spectrum. Wave aspect of particles- matter wave, de Broglie Hypothesis, Heisenberg Uncertainty principles- Statement, Interpretation and application.

Module IV: [6L]

Introduction of Crystallography

Space Lattice**,** Unit Cell, Lattice Parameters, Crystal Systems, Bravais Lattices, Miller Indices and its applications, Crystal Planes and Directions, Inter Planar Spacing of Orthogonal Crystal Systems, Atomic Radius, Co-ordination Number and Packing Factor of SC, BCC, FCC. Bragg's law and its applications.

Text Books

1. Atomic Physics Vol 1 – S.N. Ghoshal
2. Optics – Ajoy Ghak
3. Waves & Oscillation – N.K. Bajaj
4. Quantum Physics of Atoms , Molecules, Solids, Nuclei and particles – Eisberg and Resnick

Reference Books

1. Introduction to Special Relativity – Robert Resnick
2. Prespective on Modern Physics - Arthur Beiser
3. Optics – Jenkins and White
4. University Press – Sears & Zemansky
5. Introduction to modern Physics – Mani and Meheta
6. Optics – Brijlal and Subrahmanyam

Course Name : Mathematics II					
Course Code: MATH1201					
Contact hrs per week:	L	T	P	Total	Credit points
	3	1	0	4	4

Module I [10 L]

Ordinary differential equations (ODE)-

First order and first degree: Exact equations, Necessary and sufficient condition of exactness of a first order and first degree ODE (statement only), Rules for finding Integrating factors, Linear and non-linear differential equation, Bernoulli's equation. General solution of ODE of first order and higher degree (different forms with special reference to Clairaut's equation).

Second order and first degree:

General linear ODE of order two with constant coefficients, C.F. & P.I., D-operator methods for finding P.I., Method of variation of parameters, Cauchy-Euler equations.

Module II:[10L]

Basics of Graph Theory

Graphs, Digraphs, Weighted graph, Connected and disconnected graphs,Complement of a graph, Regular graph, Complete graph, Subgraph,; Walks, Paths, Circuits, Euler Graph,Cut sets and cut vertices, Matrix representation of a graph, Adjacency and incidence matrices of a graph,Graph isomorphism, Bipartite graph.

Tree:

Definition and properties, Binary tree, Spanning tree of a graph, Minimal spanning tree, properties of trees, Algorithms: Dijkstra's Algorithm for shortest path problem, Determination of minimal spanning tree using DFS, BFS, Kruskal's and Prim's algorithms.

Module III [10L]

Improper Integral:

Basic ideas of improper integrals, working knowledge of Beta and Gamma functions (convergence to be assumed) and their interrelations.

Laplace Transform:

Introduction to integral transformation, functions of exponential order, Definition and existence of LT (statement of initial and final value theorem only), LT of elementary functions, Properties of Laplace Transformations , Evaluation of sine , cosine and exponential integrals using LT, LT of periodic and step functions Definition and properties of inverse LT Convolution Theorem (statement only) and its application to the evaluation of inverse LT, Solution of linear ODEs with constant coefficients (initial value problem) using LT.

Module IV [10L]

Three Dimensional Geometry

Equation of a plane. General form. Transformation to the normal form. Intercepts. Equation of the plane through three given points. Equation of a plane passing through the intersection of two planes. Angle between two intersecting planes. Bisectors of angles between two intersecting planes. Parallelism and perpendicularity of two planes.

Canonical equation of the line of intersection of two intersecting planes. Angle between two lines. Shortest distance between two lines. Condition of coplanarity of two lines. Length of the perpendicular from a point to a given line.

References:

1. Advanced Engineering Mathematics, Erwin Kreyszig, (Wiley Eastern)
2. Graph Theory: V. K. Balakrishnan, (Schaum's Outline, TMH)
3. A first course at Graph Theory: J. Clark and D. A. Holton (Allied Publishers LTD)
4. Introduction to Graph Theory: D. B. West (Prentice-Hall of India)
5. Graph Theory: N. Deo (Prentice-Hall of India)
6. Engineering Mathematics: B.S. Grewal (S. Chand & Co.)
7. Higher Engineering Mathematics: John Bird (4th Edition, 1st Indian Reprint 2006, Elsevier)
8. Calculus: Strauss, Bradley and Smith (3PrdP edition, Pearson Education)
9. Engineering Mathematics (Volume 2): S. S. Sastry (Prentice-Hall of India)
10. Introductory Course in Differential Equations: Daniel A. Murray (Longmans & Green).
11. Co-ordinate Geometry – S. L. Loney.
12. Analytical Geometry And Vector Algebra- R M Khan

Course Name : Basic Electronics Engineering					
Course Code: ECEN1001					
Contact hrs per week:	L	T	P	Total	Credit points
	3	1	0	4	4

Module I [10 L]

Semiconductors:

Crystalline material, Energy band theory, Fermi levels; Conductors, Semiconductors and Insulators: electrical properties, band diagrams. Semiconductors: intrinsic and extrinsic, energy band diagram, electrical conduction phenomenon, P-type and N-type semiconductors, drift and diffusion carriers.

Diodes and Diode Circuits:

Formation of P-N junction, energy band diagram, built-in-potential forward and reverse biased P-N junction, formation of depletion zone, V-I characteristics, Zener Diode and its Application, Zener and Avalanche breakdown.
Simple diode circuits, load line, piecewise linear model; Rectifier circuits: half wave, full wave, PIV, DC voltage and current, ripple factor, efficiency, idea of regulation.

Module II [10 L]

Bipolar Junction Transistors:

Formation of PNP / NPN junctions, energy band diagram; transistor mechanism and principle of transistors, CE, CB, CC configuration, transistor characteristics: cut-off, active and saturation modes of operation, transistor action, input & output characteristics, load line & amplifier operation and current amplification factors for CB and CE modes. Biasing and Bias stability: calculation of stability factor.

Module III [9 L]

Field Effect Transistors:

Junction field effect transistor (JEET): Principle of operation, JFET parameters, eqv. Circuit, JFET biasing, self bias, design of bias circuits, load line, amplifier characteristics.

MOSFETs:

Construction & principle of operation of p- & n-channel enhancement & depletion mode MOSFETs, drain & transfer characteristics, threshold voltage & its control.

Cathode Ray Osilloscope:

Construction and working principle of CRO, Lissajous pattern.

Module IV [9 L]

Feed Back Amplifier:

Concept-block diagram, properties, positive and negative feedback, loop gain, open loop gain, feedback factors; topologies of feedback amplifier; effect of feedback on gain, condition of oscillation, Barkhausen criteria.

Operational Amplifier:

Introduction to integrated circuits, operational amplifier and its terminal properties; Application of operational amplifier; Concept of op-amp saturation, inverting and non-inverting mode of operation, Adders, Subtractors, Voltage follower, Integrator, Differentiator, Basic Comparator Circuit.

References:

1. Boylestad & Nashelsky:Electronic Devices & Circuit Theory
2. R.A Gayakwad:Op Amps and Linear IC's, PHI
3. D. Chattopadhyay, P. C Rakshit : Electronics Fundamentals and Applications
4. Adel S. Sedra, Kenneth Carless Smith: Microelectronics Engineering
5. Millman & Halkias: Integrated Electronics.
6. Salivahanan: Electronics Devices & Circuits.
7. Albert Paul Malvino: Electronic Principle.

Course Name : Engineering Thermodynamics & Fluid Mechanics					
Course Code: MECH1201					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

Module I [10 L]

Basic concepts of Thermodynamics:

Introduction; Macroscopic and microscopic concept; Definition of Thermodynamic systems; Surrounding, universe; Open, closed and isolated systems; Concept of control volume; Thermodynamic properties: intensive, extensive & specific properties; state.

Thermodynamic equilibrium; Change of state; Thermodynamic processes and cycles; Quasi-static processes; Reversible processes; Zeroth law of Thermodynamics -concept of temperature.

Heat & Work:

Definition of Thermodynamic work; Work transfer-displacement work for a simple compressible system, path function, PdV work in various quasi-static processes(isothermal, isobaric, adiabatic, polytropic, isochoric); Free expansion; Indicated diagram (P-V diagram) .
Definition of heat; Heat transfer-a path function; Similarities and dissimilarities between heat and work.

Module II [8 L]

First law of Thermodynamics: Statement; 1st law for a closed system executing a cycle; Concept of stored energy; Energy as a property, different forms of stored energy, internal energy, first law for a non-flow process; Flow work; Definition of enthalpy, C_p, C_v; Energy of an isolated system; Flow energy; First law for an open system - steady flow energy equation; Examples of steady flow devices(nozzle and diffuser, turbine, pump, compressor, boiler, condenser and throttling device); PMM-I

Module III [10 L]

Second law of Thermodynamics:

Qualitative difference between heat and work; Definition of source & sink: cyclic heat engine, heat pump and refrigerator, thermal efficiency of heat engine, C.O.P of heat pump and refrigerator; Kelvin-Plank and Clausius statements of second law; Equivalence of the two statements.

Reversible process; Irreversible process; Factors for irreversibility; Carnot cycle and Carnot efficiency; Reversible heat engine and heat pump; PMM-ll

Entropy: Mathematical statement of Clausius Inequality: Entropy as a property; Entropy principle; T-s plot for reversible isothermal, adiabatic, isochoric & isobaric processes.

Air standard Cycles:

Otto cycle & Diesel cycle, P-V & T-s plots, Net work done and thermal efficiency.

Module IV [10 L]

Properties & Classification of Fluid:

Definition of fluid; Concept of Continuum; Fluid properties- density, specific weight, specific volume, specific gravity; Viscosity : definition , causes of viscosity , Newton's law of viscosity, dimensional formula and units of viscosity, kinematic viscosity; Variation of viscosity with temperature. Ideal and Real fluids; Newtonian and Non-Newtonian fluids; No-slip condition.
Compressibility and Bulk modulus of elasticity.
Difference between compressible and incompressible fluids.

Fluid Statics:

Introduction; Pascal's Law--statement and proof; Basic Hydrostatic Law and its proof; Variation of pressure with depth in incompressible fluid, piezometric head, pressure head; Unit and scales of pressure measurement.
Measurement of fluid pressure: Piezometer, Manometers -Simple and Differential U-tube manometer, Inverted tube manometer, Inclined tube manometer.
Characteristics and choice of manometric fluid.

Module V [10 L]

Fluid Kinematics:

Definition; Flow field and description of fluid motion(Eulerian & Lagrangian method), steady and unsteady flow, uniform and non-uniform flow-examples.
Acceleration of a fluid particle-local acceleration, convective acceleration. Stream line, Stream tube, Path line and Streak line; Laminar and Turbulent flow, Reynolds Number. Equations of streamlines and path lines.
Continuity equation for unidirectional flow and for differential form in 3-D Cartesian coordinate system.

Dynamics of Ideal fluids:

Introduction, Euler's equation of motion along a streamline; Bernoulli's equation-assumptions and significance of each term of Bernoulli's equation.
Application of Bernoulli's equation-problem on pipe line. Measurement of flow rate: Venturimeter and orificemeter .
Static pressure, Dynamic pressure, Stagnation pressure-measurement of velocity by Pitot tube.

References:

1. Engineering Thermodynamics- Nag, P.K. - T. M.H
2. Fundamentals of Thermodynamics- Sonntag, Borgnakke & Van Wylen, Wiley India
3. Thermodynamics- an Engineering approach - 6e, Cengel & Boles, TM
4. Fluid Mechanics & Hydraulic Machines – R.K. Bansal, Laxmi Publications Ltd, India
5. Introduction to Fluid Mechanics and Fluid Machines- S.K. Som, G. Biswas, & S. Chakraborty , T.M.H
6. Fluid Mechanics – A.K. Jain, Khanna Publishers.

Course Name : Introduction to Computing Lab					
Course Code: CSEN1211					
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	3	3	2

Basic Computation & Principles of Computer Programming Lab

Softwares to be used: Cygwin and notepad++, Tiny C

Day 1: LINUX commands and LINUX based editor
Day 2: Basic Problem Solving
Day 3: Control Statements (if, if-else, if-elseif-else, switch-case)
Day 4: Loops - Part I (for, while, do-while)
Day 5: Loops - Part II
Day 6: One Dimensional Array
Day 7: Array of Arrays
Day 8: Character Arrays/ Strings
Day 9: Basics of C Functions
Day 10: Recursive Functions
Day 11: Pointers
Day 12: Structures and Unions
Day 13: File Handling

Course Name : PHYSICS I Lab					
Course Code: PHYS 1011					
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	3	3	2

1. Determination of Young's modulus by Flexure Method and calculation of bending moment and shear force at a point on the beam.
2. Determination of modulus of rigidity by Static/Dynamic Method.
3. Determination of thermal conductivity of a good conductor by Searle's Method.
4. Determination of thermal conductivity of a bad conductor by Lee's and Chorlton's Method.
5. Determination of dielectric constant of a given dielectric material.
6. Use of Carey Foster's bridge to determine unknown resistance.
7. Determination of wavelength of light by Newton's ring method.
8. Determination of wavelength of light by Fresnel's biprism method.
9. Determination of wavelength of light by Laser diffraction method.
10. Determination of dispersive power of the material of a given prism.
11. Determination of co-efficient of viscosity of a liquid by Poiseulle's capillary flow method.

Course Name : Basic Electronics Engineering Lab					
Course Code: ECEN1011					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**2**

List of Experiments

1. Familiarisation with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, multimeters etc.
2. Familiarisation with measuring and testing equipment like CRO, Signal generators etc.
3. Study of I-V characteristics of Junction diodes.
4. Study of I-V characteristics of Zener diodes.
5. Study of Half and Full wave rectifiers with Regulation and Ripple factors.
6. Study of I-V characteristics of BJTs in CB mode
7. Study of I-V characteristics of BJTs in CE mode
8. Study of I-V characteristics of Field Effect Transistors.
9. Determination of input-offset voltage, input bias current and Slew rate of OPAMPs.
10. Determination of Common-mode Rejection ratio, Bandwidth and Off-set null of OPAMPs.
11. Study of OPAMP circuits: Inverting and Non-inverting amplifiers, Adders, Integrators and

Course Name : Workshop Practice					
Course Code: MECH1011					
Contact hrs per week:	L	T	P	Total	Credit points
	1	0	3	4	3

Job 1: General awareness of a typical workshop.

Theory requirements: Workshop definition, various shops in a typical workshop, Carpentry, Fitting, Foundry; Sheet Metal Shop, Welding and Brazing Shop, Machine Shop , Forging & Blacksmithy, Safety precautions to be followed in a workshop, Familiarization of Various safety devices and their uses.

Job 2: Making of a wooden pattern.

Theory requirements: Market forms of converted Timber ,eg, log, balk, plank,batten, beam ,Types of Wood, Hard Wood, Soft Wood, particle board; Seasoning of wood, Natural seasoning, Artificial seasoning, Carpentry Tools- Marking Tools, Cutting Tools, Planing Tools, Boring Tools, Striking Tools , Holding & Misc. Tools, Carpentry Processes (marking, sawing, planning, chiselling, boring, grooving, joining etc.), Safety precautions in Carpentry Shop.

Job 3: Making of a matched profile form MS plate.

Theory requirements: Work Bench, Fitting Tools (Bench Vice,Chisel,Hammer,Different types of Files, (Rough,Bastard, Second Cut, Half Round, Triangular File),Saw(Hack saw etc.), Scriber, Punch, Try Square, Angle Plate, caliper (outside & inside), Universal Surface Gauge, Centre Punch, Prick Punch, Drill (Flat,straight fluted, taper shank twist drill).
Fitting Operations,Filing, Marking, Drilling, Tapping (Rougher,Intermediate, Finisher taps), Tap Drill size (D=T-2d), Sawing, Dieing . Safety precautions in Fitting Shop.

Job 4: Making of an internal and external thread.

Theory requirements : Thread standards and thread classifications, Internal Thread,External Thread, Thread Nomenclature (Major dia, Minor dia, Pitch dia, pitch, Lead, TPI, Metric, BSP , Nominal size), Specifications of threaded fasteners (in Metric System). Safety precautions in Dieing and Tapping.

Job 5: Making of a green sand mould using the pattern made under Job no. 2.

Theory requirements: Mould making, Preparation of sand, (silica, clay, moisture, and misc items and their functions), Properties of a good sand mould, General procedure for making a good sand mould, Different tools used for preparation of a mould, Explanation of various terms , Cope and Drag Box, Runner, Riser, Gating and its utility, Parting sand, Vent holes.

Job 6: Demonstration of metal melting and casting

Theory requirements: Metal melting furnaces: Ladles, Using of Tongs, Molten metal pouring procedure, Safety precautions in pouring molten metal in a mould.

Job 7. Making of a stepped pin in a centre lathe. (2 Classes)

Theory requirements: Machining and common machining operations , Lathe M/c and its specifications, Head stock, Tailstock, Chuck-Self centering chuck , 4 jaw chuck, Bed, Carriage, Feed mechanism, Screw cutting mechanism, various lathe operations like turning, facing, grooving, chamfering, taper turning ,Thread cutting, Knurling, Parting, Cutting speed, Feed, Depth of cut , Different types of cutting tools-Safety precautions in a machine shop.

Job 8: Making of square prism from a round shaft by Shaping Machine

Theory requirements: Description of a Shaping machine, Base , Column, Saddle, Clapper box, Quick return mechanism, Feed Mechanism, Table, Rotation of table, Adjustment of stroke length, Adjustment of starting point of cut. Safety Precautions while working in Shaping Machine.

Job 9: Making of square prism from a round shaft by Milling Machine

Theory requirements: Description of a milling machine, Specification of a Milling machine, Types of Milling-Up Milling, Down Milling, Vertical Milling Machine, Horizontal Milling Machine , Safety precautions while working in Milling Machine.

Job 10 : Arc Welding practice and making of a welded joint

Theory requirements: Welding, Weldability, Types of Welding, MMAW, Gas Welding, Electrode , Functions of Flux, Equipment for MMAW, Different types of Flames in Gas Welding and Gas Cutting (Neutral-Oxidising-Reducing Flames), Different types of welding joints, AC Welding , DC Welding; Safety precautions in Welding Shop.

Job 11 : Sheet Metal forming & Brazing

Theory requirement: Specification of sheet metal, SWG vs. mm, HR sheet, CR sheet, GI Sheet, Stainless Steel Sheet, Aluminum sheets, Tin Plates, Sheet metal working Tools, Micrometer, Chisels, Punches, Hammers, Mallets, Hand Shear or Snippets, Various sheet metal forming operations, Shearing, Marking, Punching, Drilling, Bending, Drawing, Brazing, Safety precautions in Sheet Metal Working Shop.

References:

1. Elements of Workshop Technology (Vol- I and II)- Hajra Choudhury, Media Promoter &Publishers Privet Limited.
2. Workshop Technology (Vol- I and II) – Chapman , Viva Books Privet Limited.

Mechanical Operations - CHEN 2101

Module 1 : 10 L

Particulate solids : Characterization of solid particles, particle shape, particle size, average particle size of particulate solids in terms of mean diameters like arithmetic mean diameter, mass-mean diameter, volume-mean diameter, volume-surface mean diameter. Mixed particle sizes and size analysis, specific surface of mixture.

Screen analysis : Types and Standards of screens, ideal screen, real screen, screen effective ness, differential and cumulative analysis, screen capacity, relation of screen capacity to screen effectiveness.

Screening equipment: stationary screens and grizzlies, gyrating screens, vibrating screens and other industrial screens like trammels.

Transportation and storage of solids : Concepts of Conveyor and Elevator, Studies on performance and operation of different conveyor systems like Belt, Screw, Apron, Flight, pneumatic conveyor, pipe conveyor and bucket elevators; Storage of solids and discharge pattern from storage bin, theory and measurement of granular solid flow through orifice.

Module 2 : 10 L

Comminution of solids (Size Reduction) : Factors affecting comminution, comminution laws : Kick's law, Rittinger's law and Bond's law and their limitations. Crushing efficiency & power consumption.

Size reduction equipment : Primary crusher – Jaw crusher, Gyratory crusher, Secondary crusher – Roll crusher (both smooth roll & toothed roll) its selection and capacity, Angle of Nip of Smooth Roll crusher. Grinder – Construction and operation of Hammer mill, Ball mill for dry and wet grinding, Rod mill, Attrition mill, Vertical Roller Mill for dry grinding, Agitated mill and their materials suitability, Ultra-fine grinder – Fluid energy mill, Close circuit and Open circuit operation.

Module 3 : 10 L

Separation based on particle Mechanics through liquids : Free settling and Hindered settling, Stoke's law & Newton's law regimes of settling, Expression for Settling rate in hindered settling. Gravity settling processes, gravity classifiers, sorting classifiers (Spizkasten, Elutriator, Rake classifier), differential settling methods. Clarifiers and thickeners e.g. Lamelar clarifiers, Hirate thickeners, flocculation, batch sedimentation, rate of sedimentation. Equipment for sedimentation: thickeners. Clarifier and thickener design, sedimentation zones in continuous thickeners, Concepts of Kynch's theory. Cyclones, hydrocyclones, centrifugal decanters.

Mixing : Principles and utilities of agitation, agitation equipment, flow patterns: prevention of swirling/vortex, draft tubes, Standard turbine design, power consumption, power correlation, significance of dimensionless groups, effect of system geometry, calculation of power consumption in Newtonian liquids. Solid-solid mixing equipment, Mixing effectiveness and Mixing index. Agitator scaleup.

Froth Flotation : Theory, operation, types, Flotation agents, Flotation cells.

Module 4 : 10 L

Theory and principle of solid liquid filtration, cake filters, discontinuous pressure filter: principle and working of filter press, filter press with horizontal plates, compressible and incompressible filter cakes, filter-medium resistance, constant pressure filtration, constant rate filtration, principles of cake filtration, pressure drop through filter cake, cake washing and filtration cycle, continuous vacuum filter: principle and working of rotary drum filters, continuous vacuum belt filter, centrifugal filter: theory & working principle of centrifugal filters, filter media, filter aids, Filtration of solid from gas – bag filter.

Text books:

1. Unit Operations in Chemical Engineering - W.L.McCabe, J.C.Smith and P.Harriot, McGraw-Hill, 4th Edition, 1984.
2. Chemical Engineering - J.M.Coulson, Richardson, Volume 2, 3rd Edition, Pergamon Press, 1977.
3. Mechanical Operations - R.S.Hiremath & A.Kulkarni, Volume1.

References:

1. Introduction to Chemical Engineering - Badger and Bencharo, McGraw Hill.
2. Mechanical Operations for Chemical Engineers - C.M.Narayanan & B.C.Bhattacharya, Khanna.

Fluid Mechanics - CHEN 2102

Module 1 : 10 L

Fundamental Concepts: Introduction to Fluid mechanics: Definition of Fluid, Continuum concept of fluid, concept of Knudsen number, Fluid properties : density, specific gravity, viscosity, Newtonian fluid; Non-Newtonian fluid

Fluid Statics: Basic equation of fluid statics; pressure variation in a static field; pressure measuring devices–manometer, U-tube, inclined tube, force on submerged bodies (straight, inclined), centre of pressure.

Fluid kinematics: Eulerian and Lagrangian approach, Streamline, pathline, streak line, concept of velocity and acceleration, material, temporal derivatives

Fluid dynamics: Concept of velocity –local, average, maximum, flow rate – mass, volumetric, velocity field; dimensionality of flow; flow visualization – stress field; Reynold's number—its significance, laminar, transition and turbulent flows, steady, unsteady and uniform, non-uniform flows.

Basic equations in integral form: Basic laws for a system; relation of system derivatives to the control volume formulation; conservation of mass; continuity equation.

Module 2 : 10L

Momentum balance equation: Derivation of momentum balance equation-Introduction to Navier Stoke's equation in rectangular, cylindrical coordinates, Introduction to rotational and irrotational flow, momentum correction factor.

Internal incompressible viscous flow: Navier Stokes equation and its applications in fluid flow through various geometries.

External incompressible viscous flow: Boundary layer, Basic concepts of hydrodynamic boundary layer

Introduction to Euler's Equation, Bernoulli's equation- applications of Bernoulli's equation, kinetic energy correction factor; head loss; friction factor-Fanning and Darcy, Moody diagram; major and minor losses.

Module 3 : 10 L

Flow measurement: Introduction; general equation for internal flow meters; Orifice meter; Venturimeter; concept of area meters: rotameter; Local velocity measurement: Pitot tube. Hot wire anemometer, mass flowmeter.

Open channel flow: Introduction, Flow classification, importance of Froude number, Chezy formula, Manning roughness correction, flow measurement by weirs.

Fluid moving machines: Introduction; Basic classification of pumps: Non-Mechanical Pumps—acid egg, steam jet ejector, air lift pump, Mechanical pump: Centrifugal pumps- cavitation, NPSH, Positive displacement pumps (rotary, piston, plunger, diaphragm pumps); pump specification; basic characteristics curves for centrifugal pumps; fan, blower and compressor.

Valves and fittings: Pipe fittings and valves, schedule no, equivalent diameter.

Module 4 : 10L

Fluidization: Introduction; different types of fluidization; minimum fluidization velocity; governing equation; pneumatic conveying and other industrial uses.

Fluid flow about immersed bodies: Introduction; concept of drag and lift; variation of drag coefficient with Reynolds number; stream-lined body and bluff body.

Packed bed: concept of sphericity; Ergun equation, modified friction factor.

Introduction to compressible flow: concept of speed of sound, Mach number, subsonic, supersonic flow, isentropic flow, applications.

Introduction to turbulent flow: Basic concepts, Prandtl mixing length, concept of shear velocity, Reynold's stresses.

Text book:

1. Introduction to Fluid Mechanics - Fox and McDonald, 8th Edition, Wiley Publishers.
2. Unit Operations - Mccabe Smith and Harriot, McGraw Hill Chemical Engineering Series.

References:

1. Fluid Mechanics -A.K.Jain, Khanna Publishers.
2. Transport Phenomena –R.B. Bird, W.E. Stewart, E.N. Lightfoot, John Wiley &Sons.

Energy Engineering - CHEN 2103

Module I: 10L

Introduction: Conventional (fossil energy) and non-conventional (alternative energy) resources & reserves. Global Energy production & consumption pattern. Production &consumption pattern in India.

Solid Fuels: Biomass, Wood and Charcoal. Classification & Rank of Coal, Peat ,Lignite, Sub-Bituminous coal, Bituminous coal, Anthracite coal, Cannel &Bog head coal.

Coal Reserves in India

Physical Properties of coal, Proximate & Ultimate Analysis of Coal, Cleaning, washing & Storage of coal.

Theory of coal pyrolysis and Carbonization: Low Temperature Carbonization (LTC), High Temperature Carbonization (HTC), Horizontal & Vertical Gas Retorts, Coke Ovens-Beehive& Byproduct Slot type. Recovery of byproducts. Details of Structural configuration and Operating principles.of Coke ovens including Charging and Discharging Mechanism.

Module II: 10L

Liquid Fuels: Constitution of petroleum, theory of formation of crude petroleum oil. Characterization of crude oil & petroleum fuels, on shore and off-shore oil exploration.

Parameters and testing logistics of petroleum products—Octane no., Cetane no., Pour point, Smoke point, Cloud point, Flash point, Fire point, Aniline point and Diesel index.

Processes of a typical Indian refinery involving Operation and flow-sheet of crude distillation plant; Thermal & catalytic cracking and reforming processes; coking, visbreaking, Fluid catalytic cracking and Hydrocracking.

Concept of Modern Refinery integrated with downstream petrochemicals units which manufacture naphtha-based aromatics as well as propylene-based polymers.

Liquid fuel from coal: Fischer Tropsch process.

Module III: 10L

Gaseous Fuels: Classification of gaseous fuel; Physico-chemical principles, Calorific Value, Wobbes index, and flame speed.

Producer gas, Water gas with Carburetion, oil gas, coke-oven gas, blast furnace gas, Flow sheet & operation of Natural Gas and LPG. Coal Bed Methane. Integrated Gasification Combined Cycle.

Bio Gas: Principles and Operation of Aerobic & Anaerobic digestors, Biogas generation and management& flow sheet with special reference to waste utilization.

Module IV: 10 L

Solar Energy: Devices for measurement of solar flux. Solar thermal and solar PV, Different types of Solar collectors (Flatplate, parabolic, concentric & heliostat), Solar Pond, Photovoltaic cells, Chemical storage, Efficiency of Solar devices – Tracking .

Geothermal Energy & Wind Energy: Utilization of Geo thermal Energy; Ocean Thermal Energy Conversion (OTEC).

Nuclear energy: Sources of Nuclear fuels, Indian scenario; Nuclear reactions and power generation by Nuclear reactors- Breeder reactor- reaction &operation.

Fuel Cells – Types, Construction, Principle of Operation, Applications.

Fuels from Renewable Sources – Bio Fuels 1

Preliminary concepts of Illumination Engineering—CFL and LED lights.

Text Books:

1. Fuels and Combustion (3rd Edition) – Dr. Samir Sarkar, Universities Press.
2. Elements of Fuels, Furnaces and Refractories – Prof. O.P. Gupta, Khanna publishers
3. Understanding Renewable Energy Systems - Volker Quaschning - Earthscan Ltd

Reference Books:

1. Solar energy – S.P.Sukhatme – Tata McGraw Hill
2. Fuel Cells: From Fundamentals to Applications **-** Supramaniam Srinivasan - Springer

Industrial Stoichiometry – CHEN 2104

Module I: **10L**
Units and Dimensions:, Conversion of Equations, Systems of Units, Dimensional Homogeneity and Dimensionless Quantities, Buckingham Pi-theorem for Dimensional Analysis, , Concentration of different forms, Conversion from one form to another, Raoult's Law, Henry's law, Antoine's Equation. Clausius Clapeyron Equation.

Mathematical Requisites: Use of log-log and semi-log graph paper, Triangular Diagram, Graphical Differentiation and Graphical Integration, Least Square Method, Curve Fitting, Method of Regression.

Module II: 10L
Introduction to Chemical Engineering Calculations: Basis, Mole Fraction and Mole Percent, Mass Fraction and Mass Percent, Material Balance without Chemical Reaction: Material Balance during Mixing, Humidity and Application of Psychrometric Chart, Material balance calculation of the following unit operations: Crystallization, Evaporator, Distillation Column, Absorption Column, Drier, Liquid - Liquid and Solid - Liquid Extraction Units

Module III: 10L
Material Balance with Chemical Reaction: Single Reaction, Multiple Reactions, Reactions with Recycle, Purge and By pass, Combustion Reaction, Calculation of Excess Air, Material Balance of Unsteady State Reaction systems.

Module IV: 10L
Energy Balance: Enthalpy calculation for systems (single component and multi components) without Chemical Reaction with Mean and Temperature dependent Heat Capacity, Enthalpy calculation for systems with Chemical Reactions. Heat of Reaction from Heat of Formation and Heat of Combustion Data, Effect of Temperature and Pressure on Heat of Reaction, Hess's Law, Adiabatic Reaction Temperature, Theoretical Flame Temperature Energy calculation in transient condition Case Studies: Combined Material and Energy Balances of Industrial Process.

Text Books

1. Chemical Process Principles (Part I), 2nd. Ed., O. A. Hougen, K. M. Watson, and R. A. Ragatz. John Wiley (Asian Edn.).
2. Basic Principles and Calculations in Chemical Engineering, 6th. Ed., D.M. Himmelblau: Prentice Hall,

References

1. Stoichiometry, 4th. Ed., B.I.Bhat and S.M.Vora, McGraw Hill,.
2. Elementary Principles of Chemical Processes, 3rd.Ed., R.M. Felder and R. W. Rousseau, Wiley India Edition.

Basic Enviromental Engineering and Ecology - CHEM 2001

Module 1 : 9L

Environment & Ecology general discussion. Basic ideas of environment and its component.

Mathematics of population growth: exponential and logistic and associated problems, definition of resource, types of resource, renewable, non-renewable, potentially renewable, Population pyramid and Sustainable Development.

General idea of ecology, ecosystem – components, types and function.

Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Mangrove ecosystem (special reference to Sundarban); Food chain (definition and one example of each food chain), Food web.

Biogeochemical Cycle- definition, significance, flow chart of different cycles with only elementary reaction (Oxygen, carbon, Nitrogen, Phosphorus, Sulphur).

Biodiversity- types, importance, Endemic species, Biodiversity Hot-spot, Threats to biodiversity, Conservation of biodiversity.

Module 2 : 9L

Air pollution and control

Atmospheric Composition: Troposphere, Stratosphere, Mesosphere, Thermosphere, Tropopause and Mesopause.

Green house effects: Definition, impact of greenhouse gases on the global climate and consequently on sea water level, agriculture and marine food. Global warming and its consequence, Control of Global warming. Acid rain: causes, effects and control. Earth's heat budget, carbon capture, carbon footprint

Lapse rate: Ambient lapse rate, adiabatic lapse rate, atmospheric stability, temperature inversion (radiation inversion). Atmospheric dispersion, Maximum mixing depth.

Definition of pollutants and contaminants, Primary and secondary pollutants: emission standard, criteria pollutant. Sources and effect of different air pollutants- Suspended particulate matter, oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN.

Smog: Photochemical smog and London smog. Depletion Ozone layer: CFC, destruction of ozone layer by CFC, impact of other green house gases, effect of ozone modification.

Standards and control measures: Industrial, commercial and residential air quality standard, control measure (ESP, cyclone separator, bag house, catalytic converter, scrubber (ventury), Statement with brief reference).

Module 3 : 9L

Water Pollution and Control : Hydrosphere, Hydrological cycle and Natural water. Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, thermal application, heavy metals, pesticides.

River/Lake/ground water pollution: River: DO, 5 day BOD test, Unseeded and Seeded BOD test, BOD reaction rate constants, COD.

Lake: Eutrophication (Definition, source and effect). Ground water: Aquifers, hydraulic gradient, ground water flow (definition only).

Water Treatment system (coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening) Waste water treatment system, primary and secondary treatments (Trickling filters, rotating biological contractor, Activated sludge, sludge treatment, oxidation ponds)

Water pollution due to the toxic chemicals effects: Lead, Mercury, Cadmium, Arsenic.

Noise Pollution, Definition of noise, effect of noise pollution, noise classification (Transport noise, occupational noise, neighbourhood noise). Definition of noise frequency, noise pressure, noise intensity, noise threshold limit value, equivalent noise level, L_{10} (18hr Index), effective perceived noise level.

Noise pollution control.

Module 4 : 9L

Land Pollution Solid Waste: Municipal, industrial, commercial, agricultural, domestic, pathological and hazardous solid wastes, electronic waste.

Recovery and disposal method- Open dumping, Land filling, incineration, composting, recycling.

Social Issues, Health and Environment Environmental disasters: Bhopal gas tragedy, Chernobyl disaster, Three Mile Island disaster, cancer and environment: carcinogens, teratogens and mutagens (general aspect).

Environmental impact assessment, Environmental audit, Environmental laws and protection act of India.

Energy audit, Green building, Green sources of energy, Concept of Green Chemistry, Green catalyst, Green solvents (replacement of VOC).

References/Textbooks

1. Introduction to Environmental Engineering and Science - G.M. Masters, Prentice-Hall of India Pvt. Ltd., 1991.
2. Environmental Chemistry - A. K.De, New Age International.
3. Environmental Chemistry with Green Chemistry - Asim K. Das, Books and Allied P. Ltd.
4. Environmental Science - S. C. Santra, New Central Book Agency P. Ltd.
5. Basic Environmental Engineering and Elementary Biology - GourKrishna Das Mahapatra, Vikas Publishing House P. Ltd.

Indian Culture and Heritage - HMTS 2002

Module 1 : 8L

Indian Religion &Philosophy: Orthodox Indian Philosophy, Unorthodox Indian philosophy, Essentials of Hinduism, An overview of Jainism, Buddhism, Sikhism, Islam, Christianity religions.

Module 2 : 8L

Values and Personality : Aspects of Indian Values, Essentials of Personality Building, Ethics at work place, Aspects of Leadership qualities.

Module 3 : 8L

Indian Scriptures: Selections from the Vedas, Select verses from Upanishad, An overview of Gita, XVIth chapter of Gita.

Module 4 : 8L

Indian Psychology: Aspects of Yoga Philosophy, Mind and its workings according to Yoga, Law of Karma, Selections from Manusmriti.

References / Text Books:

1. Indian Philosophy - S.C. Chatter and D. M. Dutta, Calcutta University Press.
2. Spiritual Heritage of India - Swami Prabhavananda, Sri Ramakrishna Math, Chennai.
3. Raja Yoga - Swami Vivekananda, Advaita Ashrama, Mayavati.
4. Vedic Selection - Calcutta University Press.
5. Gita - Swami Swarupananda, Advaita Ashrama, Kolkata.
6. Upanishads - Any press.
7. Carving a Sky (MSS) - Samarpan .
8. Essentials of Hinduism (MSS) - Samarpan.
9. The Call of the Vedas - Bharatiya Vidya Bhavan.

Energy Laboratory - CHEN 2111
At least eight experiments are to be performed

List of experiments:

1. Proximate analysis of Coal.
2. Determination of carbon residue of fuel oil.
3. Determination of aniline point of a fuel oil.
4. Determination of moisture content of fuel oil by Dean & Stark apparatus.
5. Atmospheric Distillation of a petroleum product.
6. Determination of Flash Point & Fire Point of an oil by Abel apparatus.
7. Determination of Flash Point & Fire Point of oil by closed-cup Pensky Marten apparatus.
8. Determination of kinematic viscosity of oil by Redwood Viscometer.
9. Determination of calorific value of gaseous fuel by Junker's apparatus.
10. Determination of calorific value of solid and liquid fuel by Bomb Calorimeter.
11. Determination of vapour pressure of petroleum product using Reid apparatus.
12. Experiments on Non-conventional Energy Source using Solar Cooker/Flat Plate
13. Analysis of a gaseous mixture by Orsat apparatus.
14. Calibration of Pyrometer.

Fluid Mechanics Lab - CHEN 2112
At least eight experiments are to be performed

List of experiments:

1. Determination of coefficient of discharge at various Reynold's number during fully developed fluid flow through orificemeter.

2. Determination of coefficient of discharge at various Reynold's number during fully developed fluid flow through venturimeter.

3. Determination of loss coefficient of pitot tube and construction of fully developed velocity profile through pipe in laminar and turbulent flow regime.

4. Measurement of open channel flow and determination of coefficient of discharge V-notch and rectangular notch.

5. Determination of pressure drop for flow through packed bed and verification of Ergun equation.

6. Determination of characteristic curve of a centrifugal pump.

7. Experiments on Reynold's apparatus for determination of flow regime and construction of fanning's friction factor vs Reynold's number plot.

8. Determination of pressure drop and bed height profile with varying modified Reynold's number during flow through a fluidized bed. Determination of incipient fluidization.

9. Calibration of rotameter.

10. Determination of viscosity of Newtonian and non-Newtonian fluid.

11. Assembling of pipe line and fitting according to a given layout.

Mechanical Operations Laboratory - CHEN 2113
At least eight experiments are to be performed

List of experiments:

1. Sieve Analysis: To analyze a given powder for its particle size distribution. / Cumulative and Differential methods of particle size distributions.

2. Overall Screen Effectiveness: To find out screen efficiency through a suitable material balance with respect to a single screen.

3. Jaw Crusher: To find out the reduction ratio and capacity and to verify Rittinger's Law.

4. Ball Mill: To determine the reduction ratio, capacity and the critical speed of the ballmill.

5. Rod Mill: To determine the reduction ratio and capacity and compare the reduction atio for the same feed sample to that in a ball mill.

6. Hammer Mill: To find out the reduction ratio and capacity.

7. Batch sedimentation: To determine the settling and sedimentation characteristics of given slurry.

8. Elutriator: To study the sorting of a given mixture in an elutriator.

9. Filtration: To determine the specific cake resistance and filter medium resistance in the given plate and frame filtration.

10. Mixing: To determine the power number and power consumption for a given liquid in an agitated vessel.

11. Cyclone Separator: Demonstration of the operation of a cyclone separator and determination of its overall collection efficiency.

12. Hard Grooved Instrument: To determine the work index of a given brick sample.

Chemical Engineering Drawing Lab - CHEN 2114

1. Introduction to AUTOCAD software for drawing in 2D: Drawing and editing commands. Knowledge of setting up layers, dimensioning, hatching, making block, plotting and printing, working with external reference file.

2. Drawing *any three* of the following item using AUTOCAD software.

a) Flange coupling for shaft and vessel or pipe.
b) Pipe joints and fittings, single line and double line pipe line assembly
c) Stuffing box.
d) Detailed cut section drawing of Globe valve and Stop valve.
e) Piping and instrumentation diagram of any given chemical process.

3. Assembly drawing of a single stirred jacketed pressure vessel with all its accessories using AUTOCAD software**.**

4. Introduction to AUTOCAD software for drawing in 3D: Working in 3-dimensions, Drawing and editing commands, viewing 3D objects, basic solid and wireframe models, extruding, simple revolved objects. Generation of orthographic projections from 3D drawing.

Human Values and Professional Ethics - HMTS 2001

Module 1 : 8L

Human society and the Value System:
Values, definition, importance and application. Formation of Values: The process of Socialization, Self and the integrated personality Morality, courage, integrity.
Types of Values: Social Values, Justice, Rule of Law, Democracy, Indian Constitution, Secularism Aesthetic Values: Perception and appreciation of beauty.
Organizational Values: Employee: Employer--- rights, relationships, obligations .
Psychological Values: Integrated personality and mental health.
Spiritual Values &their role in our everyday life.
Value Spectrum for a Good Life, meaning of Good Life .
Value Crisis in Contemporary Society:Value crisis at Individual Level, Societal Level, Cultural Level.
Value Crisis management - Strategies and Case Studies.

Module 2 : 8L

Ethics and Ethical Values.
Principles and theories of ethics.
Consequential and non-consequential ethics.
Egotism,Utilatirianism, Kant's theory and other non-consequential perspectives..
Ethics of care, justice and fairness, rights and duties.
Ethics: Standardization,Codification, Acceptance,Application .
Types of Ethics:Ethics of rights and Duties, Ethics of Responsibility, Ethics and Moral judgment, Ethics of care,Ethics of justice and fairness,Work ethics and quality of life at work.
Professional Ethics:
Ethics in Engineering Profession;moral issues and dilemmas, moral autonomy(types of inquiry).
Kohlberg's theory, Giligan's theory(consensus and controversy).
Code of Professional Ethics Sample Code of ethics like ASME, ASCE. IEEE,Institute of Engineers,Indian Institute of materials management, Institute of Electronics and telecommunication engineers.
Violation of Code of Ethics: conflict, causes and consequences
Engineering as social experimentation, engineers as responsible experimenters (computer ethics, weapons development);Engineers as managers, consulting engineers, engineers as experts, witnesses and advisors, moral leadership; Conflict between business demands and professional ideals,social and ethical responsibilities of technologies.
Whistle Blowing: Facts, contexts, justifications and case studies
Ethics and Industrial Law.
Institutionalizing Ethics: Relevance, Application, Digression and Consequences.

Module 3 : 8L

Science, Technology and Engineering as knowledge and profession ; Definition, Nature, Social Function and Practical application of science.
Rapid Industrial Growth and its Consequences.
Renewable and Non- renewable Resources: Definition and varieties.
Energy Crisis.
Industry and Industrialization.
Man and Machine interaction.
Impact of assembly line and automation .
Technology assessment and Impact analysis.
Industrial hazards and safety.
Safety regulations and safety engineering.
Safety responsibilities and rights.
Safety and risk, risk benefit analysis and reducing risk.
Technology Transfer: Definition and Types, The Indian Context.

Module 4 : 8L

Environment and Eco- friendly Technology :Human Development and Environment; Ecological Ethics/Environment ethics;Depletion of Natural Resources: Environmental degradation
Pollution and Pollution Control
Eco-friendly Technology: Implementation, impact and assessment
Sustainable Development: Definition and Concept
Strategies for sustainable development
Sustainable Development--- The Modern Trends
Appropriate technology movement by Schumacher and later development Reports of Club of Rome.

Textbook/References

1. Human Values, New Age International - A.N.Tripathi, New Delhi, 2006.
2. Classical Sociological Theory - G.Ritzer, The McGraw Hill Companies, New York, 1996.
3. Postmodern Perspectives on Indian Society - S.L.Doshi, Rawat Publications, New Delhi, 2008.
4. Sustainable Development - D.K.Bhatnagar, Cyber Tech Publications, New Delhi, 2008.
5. The age of Spiritual Machines - R.Kurzwell, Penguin Books, New Delhi, 1999.
6. Social Problems in Modern Urban Society - Weinberg, Prentice Hall, Inc., USA, 1970.
7. Sociology - Anthony Giddens, London: Polity Press 2009.

Chemistry II - CHEM 2201

Module 1 : 9L

Colloids: Introduction; Classification of colloids; Size and shape; preparation of sols; Origin of charge in Colloidal particles; Stability of Colloids; Kinetic, Optical & electrical properties; Electrokinetic phenomena; Electrical Double Layer; Ultracentrifuge and Molecular weight determination of Macromolecules.

Kinetic theory of gases, Van der Waals Equation of state, Maxwell distribution law, vapour-liquid equilibrium

Adsorption: Introduction; Gibb's adsorption equation; Surface Excess; Adsorption isotherms: Freundlich, Langmuir, BET adsorption equations; Surface Films; Langmuir Balance; two dimensional equation of state.

Module 2 : 9L

Solution thermodynamics: Duhem Margulas equation and its application, concept of fugacity, activity and activity coefficients and their measurements.

Colligative properties of dilute solutions: vapour pressure lowering and osmotic pressure, thermodynamic derivation of their relationship, semipermeability, reverse osmosis, elevation of boiling point and depression of freezing point, van't Hoff factor, molar mass and colligative properties, experimental determination of colligative properties.

Module 3 : 9L

Preparation and synthetic application Grignard's reagent.

Common organic reactions i.e. Friedel-Crafts, Cannizaro, Aldol condensation, Beckmann, Schmidt, Lossen, Curtius Rearrangements.

Industrial Preparation: Synthesis of commercially important compounds (e.g. industrial reactions of phthalic anhydride from xylene and naphthalene, DDT from chlorobenzene, aspirin and methyl salicylate from phenol).

Module 4 : 9L

Aminoacids: Classification; General methods of preparation and properties of amino acids, polypeptide synthesis.

Carbohydrate: Classification, Glucose and fructose, Disaccharides: Sucrose & maltose.

Text Books:

1. Physical Chemistry - G.W.Castellan, Narosa.
2. Organic Chemistry - I.L.Finar, Vol I & II, Pearson Education.
3. Organic Chemistry - Morrison & Boyd, PHI/Pearson Education.
4. Physical Chemistry – P. C. Rakshit, Sarat Book House 7th Edition

Reference Books:

1. Physical Chemistry - P. W. Atkins, Oxford.
2. A Text book of Physical Chemistry - K. L. Kapoor, Macmillan.
3. A guide Book to Mechanism in Organic Chemistry - Peter Sykes.
4. Organic Chemistry – Loudon, Oxford.

Data Structure & Database Concept - CSEN 2201

DATA STRUCTURE

Module 1 : 10L
Linear Data structures:
Sequential Representation, Arrays, Lists, Stacks, Queues, Circular Queue, De-queue
Linked List Representations: Linear Linked List, Circular Linked List, Doubly Linked List and their Application.
Implementation of Stack, Queue and their variations using linked list
Recursion: Design of Recursive algorithm, Tail Recursion.

Module 2 : 13L
Non-Linear Data Structures:Trees : Binary Trees, Traversals, Binary Search Trees- Insertion and Deletion algorithms, AVL Tree, Heap(Definition and basic concepts)
Graphs: Breadth First Search (BFS) and Depth First Search (DFS).
Sorting Algorithms: Bubble sort, Insertion sort, Selection sort, Quick sort.
Searching Algorithms: Linear search, Binary search.

DATABASE CONCEPT

Module 3 : 10L
Introduction to Database Concepts, File Processing System and Database Management System , DBMS Architecture and Data Independence,.
Data Model: Basic Concepts, Entity-Relationship Diagram, Keys, Cardinality, Weak Entity Set.
Introduction to relational algebra & SQL: Operators like select, project, rename, artesian product, join, union, intersect, minus, DDL, DML.

Module 4 : 12L
Relational Database Design: Functional Dependencies, Normalization: Different anomalies in database designing 1NF, 2NF, 3NF and BCNF, Lossless-Join Decomposition and Dependency Preservation,
Introduction to Transaction Processing Concepts: ACID properties, Serializability and Recoverability

Text Books :
Data Structures:

1. Data Structures - Seymour Lipschutz, Publication: Tata McGraw-Hill (India)
2. Data Structures and Program Design in C. - Kruse Robert L., Robert Kruse, Cl Tondo, Pearson Education India.

Database Concept:

1. Fundamentals of Database Systems - Elmasri Ramez and Navathe Shamkant, Publication: Pearson.
2. Database System Concepts - A. Silberschatz, H.F Korth, S.Sudarshan, McGraw Hill Education (India) Private Limited.

Reference Books:

Data Sturucture:

1. Data Structures using C. - A.S.Tanenbaum, Y. Langsam, M.J.Augenstein, Publication: Pearson
2. The Art of Computer Programming - Donald E. Knuth , Addison-Wesley Professional.

Database Concept:

1. Introduction to Database Management - Vol. I, II, III, Date C. J.,Publication: Addison Wesley.
2. Principles of Database Systems - J.D.Ullman, Galgottia Publication.

Process Heat Transfer - CHEN 2201

Module 1 : 10L

Introduction to basic modes of heat transfer and their application in chemical process, heat transfer by conduction: Fourier law, thermal conductivity, thermal resistance; general heat conduction equation, thermal diffusivity; steady state heat conduction with heat generation for plane wall, cylindrical body and spherical body; conduction-convection system: critical insulation thickness of curved surface, steady state heat conduction through fin, fin efficiency, unsteady state heat conduction in solid with large thermal conductivity, significance of Biot no and Fourier no, transient heat conduction in solid.

Module 2 : 10L

Convective heat transfer without phase change: Newton-Rikhman law, local and average heat transfer coefficient, Reynold-Colburn analogy, concept of individual heat transfer coefficient and overall heat transfer coefficient, LMTD, empirical correlation for heat transfer coefficient in forced convection; elementary concept of thermal boundary layer, temperature distribution in laminar flow, analysis of free convection and correlation of free convection, Grashof number.

Module 3 : 10L

Heat transfer with phase change: filmwise and dropwise condensation, laminar film condensation on vertical plate, Nusselt equation; analysis of heat transfer during boiling, different boiling regimes during pool boiling.

Characteristics of radiation, properties of radiating surface, black body radiation: Plank's distribution law, Total emissive power: Stefan-Boltzman law, use of radiation function table; Wien's displacement law; Kirchoff's law; emissivity of black body, gray body and real body; radiation between surfaces: view factor, Electrical network approach for radiation heat exchange, radiation shields and their application, radiation heat exchange for three radiating surfaces; radiation heat transfer through absorbing emitting medium.

Module 4: 10L

Heat exchangers and their classification, performance analysis of heat exchanger: fouling factor, LMTD correction factor, effectiveness and NTU of heat exchangers, sizing and rating problems of heat exchangers, construction details of shell and tube heat exchanger, Shell and Tube heat exchanger design, elementary note on heat exchanger network.

Evaporators and their classification, capacity and steam economy, BPE, material and energy balance of single effect evaporator, classification of multiple effect evaporator, design of single effect and multiple effect evaporator.

Text Books:

1. Process Heat Transfer - D. Q. Kern, MGH.
2. Heat Transfer Principles and Application - B. K. Dutta, PHI.
3. Units Operations of Chemical Engineering - McCabe & Smith and Harriot, MGH.

References:

1. Heat Transfer - A Basic Approach: M. Necati Ozisik, McGraw-Hill International Edition, Singapore.

Separation Processes I - CHEN 2202

Module 1 : 10L

Principles of molecular diffusion and diffusion between phases, Fick's Law, Diffusivity, Equation of continuity, Diffusion in solids, Knudsen diffusion. A definition of Mass transfer coefficient, other definitions of mass transfer coefficient, Correlation involving mass transfer coefficients, Theories of mass transfer, Mass transfer across interfaces, Two-resistance theory, Analogy between momentum, heat and mass transfer.

Module 2 :10L

Introduction to distillation , Vapor -liquid equilibria, Relative volatility, Ideal and non -ideal solutions, Batch Distillation, Rayleigh equation, Flash distillation, Steam distillation, Rectification of binary systems, Reflux ratio, Boil-up ratio, Fenske's Equation, Flooding, Dumping, Coning in a plate column, Calculation of number of plates in a distillation column by Mc Cabe-Thiele method, Enthalpy- concentration diagram, Calculation of number of plates in a distillation column by Ponchon -Savarit method, Optimum reflux ratio, **,** Plate efficiency.

Module 3 : 10L

Introduction to absorption, The mechanism of absorption, Absorption equipment, Limiting gas-liquid ratio, Flooding, loading in packed column, Diameter and height calculations for packed columns, H. E. T. P., H. T. U. and N. T. U. concepts, Packed tower design, Gas film coefficient, Liquid film coefficient, Height of column based on overall coefficients, Number of plates and Diameter of Plate type towers, Absorption factor, Number of plates by use of absorption factor, Kremser equation.

Different types of Gas-liquid contacting devices for absorption and distillation operation: gas continuous-liquid dispersed and liquid continuous-gas dispersed.

Module 4 : 10L

a. Distillation Column internals and sizing, Azeotropic & Extractive distillation, Multi-component distillation.

b. Adsorption: Introduction, Nature of adsorbents, Batch adsorption, Adsorption isotherms, Adsorption equipment, Breakthrough curves, Scale up, Length of unused bed, Design of fixed bed adsorption column.

Text Books :

1. Mass Transfer Operations: Robert E. Treybal, MGH, International Student Edition.
2. Principles of Mass Transfer and Separation Processes, Binay K. Dutta
3. Unit Operations in Chemical Engineering : McCabe, Smith, and Harriot. MGH, Sixth Edn.

References :

1. Transport process and Unit Operations: Geankoplis. 3rd Edn., PHI.
2. The Elements of Fractional Distillation: Robinson, C. S. and Gilliland, E. R. MGH.
3. Separation Processes: King, C. J. MGH.
4. Separation Process Principles : J.D.Seader, E.J. Henley.
5. Coulson & Richardson's Chemical Engineering, Vol.2.
6. Distillation Design, Henry Kister, MGH.

Chemical Engineering Thermodynamics – CHEN 2203

Module I :10L

Introduction-Macroscopic and microscopic approaches; Units; Basic concepts of system, property, force, temperature, pressure, work, energy, heat and equilibrium from thermodynamic aspect.

Application of 1st law of thermodynamics to chemical process: open and closed system energy balance equations, SFEE, compressible flow through a nozzle, working principle of single stage and multistage compressor.

P-V-T behaviour of pure substances, equation of state: virial equation of state, cubic equation of state, law of corresponding states, generalised correlations for gases and liquids, acentric factor, compressibility factor.

Module II : 10L

Application of second law of thermodynamics to chemical process, entropy generation and irreversibility, clausius inequality.

Ideal power cycle, Rankine cycle, reheat cycle, regenerative cycle, and working principle of IC engine: Otto cycle, diesel cycle, brayton cycle.

Ideal refrigeration cycle, vapour compression cycle, Bell-Coleman cycle, absorption refrigeration cycle, isenthalpic expansion: Linde and Claude liquefaction cycle.

Module III : 10L

Thermodynamic property relations of pure fluid: Maxwell relations. The Jacobian Method, residual property, physical significance of Gibb's free energy and work function, concept of fugacity.

Solution thermodynamics: partial molar properties, chemical potential, Gibbs-Duhem equation, effect of temperature and pressure on chemical potential, fugacity in solution, Lewis-Randall rule and Henry's law, Raoult's law, excess property, activity and activity coefficient, property change on mixing, Excess Gibbs free energy models – Margules, Redlick – Kister, Whol's, Van Laar, Wilson & NRTL, UNIQUAC, Group Contribution methods, modified Raoult's law, P-x-y and T-x-y diagram of binary liquid solution, azeotrope calculation, thermodynamic consistency checking of data.

Module IV : 10L

Chemical reaction equilibria: Reaction Stoichiometry, reaction coordinate, criteria of reaction equilibrium, equilibrium constant, standard Gibbs energy change and equilibrium constant, effect of temperature on equilibrium constant, effect of pressure on equilibrium constant, effect of inert material, excess reactant and product on equilibrium constant, heterogeneous reaction equilibria, phase rule and Duhem theorem for reacting system.

Text Books:

1. Introduction to Chemical Engineering Thermodynamics: Smith, J.M., Van ness, H.C. and Abbot, M.M., 6th Edn. MGH., 2001.
2. A Text Book of Chemical Engineering Thermodynamics, Narayanan, PHI

References:

1. Chemical Engineering Thermodynamics: Y.V.C. Rao.
2. Chemical Process Principles (Vol-2): O.A.Hougen, K.M. Watson and R.A.Ragatz.
3. Chemical and Process Thermodynamics: Kyle PHI.

DBMS Laboratory - CSEN 2211

Experiments on Database on RDBMS Platform (Oracle):

DDL Commands: Creating Tables along with constraints like: Primary Key, Foreign Key, unique, Not Null, Check. Altering Table Structure like adding and modifying constraints, adding and modifying column data types, etc..

DML: Inserting rows, Updating rows, Deleting rows

SQL Query: Cartesian Product, Join, Union, Intersect, Minus, Single Row functions, multiple row functions using GROUP BY clause, ORDER BY Clause, Nested Sub-Queries

Introduction to PL/SQL: Programming Language Constructs in PL SQL like variable declaration, Conditional Statements, different types of loop structures, functions, etc. Programming using Cursors, Creating different types of Triggers.

Reference Books:

1. SQL, PL/SQL: The Programming Language Of Oracle (With CD-ROM) (English) 4th Revised Edition: Ivan Bayross,Publisher: BPB Publications.

Heat Transfer lab - CHEN 2211

At least eight experiments are to be performed

List of experiments:

1. Determination of thermal conductivity of a metal bar using Fourier's heat conduction equation.

2. Estimation of heat loss through a lagged pipe and determination of thermal conductivity of insulating material.

3. Determination of thermal conductivity of insulating powder during heat transfer in a spherical vessel.

4. Determination of heat transfer coefficient of air during forced convection heat transfer and to study the effect of air velocities on heat transfer coefficient.

5. Determination of overall heat transfer coefficient in a Counter current & Parallel flow double pipe heat exchanger and to study the effect of fluid flow rate on overall heat transfer coefficient.

6. Determination of overall heat transfer coefficient and efficiency of a Shell and Tube heat exchanger and to study the effect of fluid flow rate on overall heat transfer coefficient.

7. Determination of emissivity of a given radiating surface applying Kirchhoff's law of thermal radiation.

8. Determination of Stefan's Boltzman constant experimentally.

9. Determination of economy, capacity and overall heat transfer coefficient of a single effect evaporator.

10. Determination of Biot number for a conductive convective system and validation of lumped system assumption.

11. Determination of heat transfer co-efficient in film-wise & drop-wise condensation.

Language Practice Lab Level II - HMTS 2011

Module 1 : 8L

Formal verbal communication: Introduction to formal verbal communication, Interpersonal Skills & Public Speaking: Building Positive Relationships, Focusing on Solving Problems, Time Management, Dealing with Criticism: Offering Constructive Criticism, Responding to Criticism – Managing Conflict: Approaches to Conflict, Resolving Conflict.

Conversational skills in the business scenario: One-to-one and Group communication, Gender and Culture Sensitivity, Etiquette, Sample Business Conversation, Telephonic Conversation.

Module 2 : 8L

Presentation skills:

Speech Purposes : General Informative Speeches, Persuasive Speeches, Entertaining Speeches, Methods of Speaking: Speaking from a Manuscript, Speaking from Memory, Impromptu Delivery, Extemporaneous Delivery, Analyzing the Audience, Nonverbal Dimensions of Presentation.

Organising the Presentation: the Message Statement, Organising the Presentation: Organizing the Speech to Inform, The Conclusion, Supporting Your Ideas – Visual Aids: Designing and Presenting Visual Aids, Selecting the Right Medium, Post- presentation Discussion.

Module 3 : 8L

Group Discussion

Introduction to Group Communication

Factors in Group Communication, Status – Group Decision Making: Reflective Thinking, Brainstorming, Body Language, Logical Argument, The Planning Process, Strategies for Successful GDs, Role of Social Awareness (Newspapers, Magazines, Journals, TV News, Social Media), Practice GDs.

Module 4 : 8L

Job Application and Personal Interview: Job Application Letter: Responding to Advertisements and Forced Applications, Qualities of Well-Written Application Letters: The You-Attitude, Length, Knowledge of Job Requirement, Reader-Benefit Information, Organization, Style, Mechanics – Letter Plan: Opening Section, Middle Section, Closing Section.

Resume and CV: Difference, Content of the Resume – Formulating Career Plans: Self Analysis, Career Analysis, Job Analysis, Matching Personal Needs with Job Profile – Planning your Resume – Structuring the Resume: Chronological Resume, The Functional Resume, Combination Chronological and Functional .Resume – Content of the Resume: Heading, Career Goal or Objectives, Education, Work Experience, Summary of Job Skills/Key Qualifications, Activities, Honours and Achievements, Personal Profile, Special Interests, References .

Interviewing: Types of Interviews, Format for Interviews: One-to-one and Panel Interviews, Employment Interviews, Frequently Asked Questions, Dress Code, Etiquette, Questions for the Interviewer, Simulated Interviews.

References:

1. The Cambridge guide to Teaching English to Speakers of Other Languages - R.Carter, And D.Nunan, (Eds) CUP, 2001.
2. Writing and Speaking At Work: A Practical Guide for Business Communication - Edward P. Bailey, , Prentice Hall, 3rd Ed., 2004.
3. Guide to Managerial Communication: Effective Business Writing and Speaking - M.Munter, Prentice Hall, 5th Ed., 1999.
4. Technical Communication: Principles and Practice - M.Raman and S.Sharma, 2nd Ed., 2011.

B.Tech-3rd year-5th semester

Economics for Engineers (HMTS-3101)

3L/week **Credit-3**

Module 1:

Market: Meaning of Market, Types of Market, Perfect Competition, Monopoly, Monopolistic and Oligopoly market.

The basic concept of economics – needs, wants, utility.

National Income-GDP, GNP. Demand & Supply, Law of demand, Role of demand and supply in price determination, Price Elasticity.

Inflation: meaning, reasons, etc. **(6L)**

Module 2:

Business: Types of business, Proprietorship, Partnership, Joint-stock company, and cooperative society – their characteristics.

Banking: role of commercial banks; credit and its importance in industrial functioning. Role of central bank: Reserve Bank of India.

International Business or Trade Environment. **(4L)**

Module 3:

Financial Accounting-Journals. Ledgers, Trial Balance, Profit & Loss Account, Balance Sheet.

Financial Statement Analysis (Ratio and Cash Flow analysis). **(8L)**

Cost Accounting- Terminology, Fixed, Variable and Semi-variable costs.

Break Even Analysis. Cost Sheet. Budgeting and Variance Analysis.

Marginal Cost based decisions. **(6L)**

Module 4:

Time Value of Money: Present and Future Value, Annuity, Perpetuity.

Equity and Debt, Cost of Capital. **(4L)**

Capital Budgeting: Methods of project appraisal - average rate of return - payback period - discounted cash flow method: net present value, benefit cost ratio, internal rate of return.

Depreciation and its types, Replacement Analysis, Sensitivity Analysis. **(8L)**

Evaluation: Max marks-100

Internal Test-30

Semester Test-70

Suggested Readings:

1. R**.** Narayanswami, *Financial Accounting- A Managerial Perspective.* Prentice-Hall of India Private Limited. New Delhi

2. Horne, James C Van, *Fundamentals of Financial Management*. Prentice-Hall of India Private Limited, New Delhi

3. H. L. Ahuja., *Modern Economic Theory*. S. Chand. New Delhi.

4. Newman, Donald G., Eschenbach, Ted G., and Lavelle, Jerome P. *Engineering Economic Analysis.* New York: Oxford University Press. 2012.

Chemical Process Technology-I - CHEN 3101

Module 1: 10 L

Water treatment: Water for the chemical process industry, Boiler feed-water, Cooling tower water, Demineralised water, Drinking water; Treatment methodology: Conventional water-treatment procedures, Ion-exchange, Membrane technology etc.

Chlor-alkali industries: Production and consumption pattern, manufacture of Chlorine-caustic soda: Raw materials, principles of manufacture, Mercury-cathode & Membrane process: flow-sheet and sequence of operation, other processes, advancement of process technology and major engineering problems, uses.

***Soda-ash* :** Production and consumption pattern, Raw materials, Solvay process Physico-chemical principles of manufacture, carbonation and ammonia recovery step, flow-sheet and sequence of operation, other processes, advancement of process technology and modified Solvay process, major engineering problems, uses.

Module II: 10 L

Industrial Acids:

Hydrochloric Acid: Manufacturing methods: By product Recovery from other production processes, conventional raw materials and principles of manufacture, flow-sheet and sequence of operation, major engineering problems, uses.

Sulfuric acid: Raw materials resources, sulfuric acid production processes, Contact process, Physico-chemical principles and general theory of contact reaction with thermodynamic and reaction engineering aspects, different types of catalyst – preparation methodology and relative merits, flow-sheet and sequence of operation, details of major equipments, advancement of process technology and major engineering problems, DCDA process, uses.

Nitric Acid: Raw materials resources, Ostwald Process–physico-chemical principles, catalyst, process flow sheet and sequence of operation, details of major equipments, uses.

Phosphoric Acid: Raw materials, manufacturing process with process flow sheet, details of major equipments, uses.

Module III: 10 L

Fertilizer Industries:

Nitrogenous fertilizers: Ammonia-Source of hydrogen; methods of obtaining hydrogen from different sources, source of nitrogen-liquefaction of air and distillation of liquid air;

Synthesis of ammonia- physico chemical principles, catalyst for synthesis of ammonia, process flow sheet and sequence of operation, details of major equipments.

Urea - Raw materials, manufacturing process with flow sheet, sequence of operation, major equipments details.

Ammonium sulphate: Raw materials, manufacturing process with flow sheet, major equipments details.

Phosphatic fertilizers: Manufacturing process of super phosphate of lime, single and triple super phosphate, Diammonium phosphate.
Mixed fertilizers: NPK –manufacturing process, details of major equipments;

Module IV: 10 L
Ceramic and ceramic materials:
Cement: Chemical composition of Portland cement, raw materials, dry and wet process for manufacturing cement clinker, setting and hardening of cement.
Glass: Composition of glass, raw materials, manufacturing method of glass- pot furnace and tank furnace, annealing of glass.
Ceramic: Basic raw materials, white-wares, manufacturing process of porcelain and their forming operations.
Refractories: Properties of Refractories, raw materials, manufacturing techniques of acid refectories, basic Refractories, sintered and fused refractories, insulating refractories.

Text Books :

1. Dryden, C. E., and Rao, M.G. (Ed.), Outlines of Chemical Technology Affiliated East West Press
2. Austins, G.T., Sherve's Chemical Process Industries, McGraw-Hill, 5th Edn.
References:
1. Venkateswarlu, S. (Ed.) Chemtech (II) Chemical Engineering Development Centre, Indian Institute of Technology, Madras
2. Kirk & Othmer (Ed.), Encyclopedia of Chemical Technology.

Chemical Reaction Engineering - CHEN 3102

Module I: 10L

Introduction; Definition of reaction rate; Kinetics of homogeneous reaction: Concentration-dependent term of a rate equation, single and multiple reactions, rate equation from given mechanisms.

Elementary & Nonelementary reactions, Molecularity and order of reaction, Representation of reaction rate, Kinetics for non elementary reactions, related problems, Temperature dependent term of a rate equation: Arrhenius law, Collision theory, Transition-state Theory, related problems.

Interpretation of batch reactor data: Constant-volume batch reactor, Integral method of analysis of data: General Procedure, Irreversible unimolecular-type first-order reaction, Irreversible bimolecular-type second-order reactions, rate equation for enzymatic reaction, Zero-order reactions, Over-all order of irreversible reactions from the Half-life method, Initial rate method of analysis.

Irreversible Reactions in parallel, Autocatalytic reactions, Irreversible reactions in series, First-order Reversible Reactions, Differential method of Analysis of data: Analysis of the Complete Rate Equation, Partial analysis of rate equation,

Variable-Volume reaction system: Its Integral method of analysis for Zero-order reactions, First order reaction, Second-order reactions;

Module II: 10L

Single ideal Reactors: Introduction; Basic division of ideal reactors, Ideal Batch Reactor, Concept of flow reactors, Space-time and Space-velocity,

Steady-state Mixed Flow Reactor: Design Equation, Graphical Representation of Design Equation, related problem;

Steady-state Plug Flow Reactor: Design equation, graphical representation, related problem;Design for Single Reactions: Size and comparison of single reactors: Batch Reactor, PFR, MFR, General Graphical Comparison;

Multiple-Reactor Systems: PFRs in Series and/or in Parallel, Equal-size MFRs in Series, MFRs of different sizes in Series, Determining the best size combination of reactor size for a given combination, Reactors of Different Types in Series,

Recycle Reactor: Definition of Recycle Ratio, Design Equation, and Optimum Recycle ratio.

Module III: 10L

Design for Multiple Reactions: Introduction, Reactions in Parallel, Qualitative aspects of Product Distribution,

Quantitative Treatment of Product Distribution and of Reactor Size: Definition of Instantaneous and Overall fractional yield, graphical representation; Reactions in Series: Successive First-Order Reactions, Product Distribution, Quantitative Treatment of PFR, MFR and Batch Reactor.

Solid-Catalyzed Reaction: Introduction; Basic idea of catalysis, Catalyst properties, Steps in catalytic reaction:

Qualitative discussion on Pore Diffusion, Adsorption, Surface reaction and Desorption, Concept of Rate limiting step;

Design of reactors for gas-solid reactions: Design equation and data analysis of heterogeneous system; Quantitative aspects of Pore diffusion controlled reactions (single cylindrical pore, first-order reaction): Material balance for the elementary slice of catalyst pore, Definition of Thiele Modulus and Effectiveness Factor.

Different methods of catalyst preparation. Catalyst surface area and pore volume measurement

Fluid-Particle Reactions: Introduction; Different behavior of reacting solid particles; Selection of a Model; Qualitative discussion on Progressive Conversion Model & Unreacted Core Model;

Introduction to non isothermal reactions: adiabatic and temperature programmed reactions.

Module IV: 10L

Distribution of Residence Times for Chemical Reactors: General Characteristics; Residence-Time Distribution (RTD) Function;

Measurement of the RTD: Pulse Input; Related problems; Characteristics of RTD: Integral Relationships, Mean Residence Time, Different Moments of RTD; RTD in Ideal Reactor: RTD in Batch and PFR, Single CSTR, PFR/CSTR series RTD; Concept of Macromixing & Micromixing, Zero Parameter Model: Segregation Model & Maximum Mixedness Model.

Models for Nonideal Reactors: Introduction; One-Parameter Models: Tanks in Series Model, Dispersion Model: Basic Formulation, Definition of Peclet Number & Vessel Dispersion Coefficient, Boundary Conditions (Closed-Closed & Open-Open), Correction for Sloppy Tracer Input, Relation between Flow, Reaction and Dispersion.

Text Books :

1. Elements of Chemical Reaction Engineering, 4th. Edition, H. Scott Fogler, Prentice Hall
2. Chemical Reaction Engineering, 2nd. & 3rd. editions, O Levenspiel.: Wiley Eastern Ltd.

References:

1. Chemical Reactor Analysis and Design Fundamentals, J. B. Rawlings and J. G. Ekerdt. Nob Hill Publishing.
2. Chemical Engineering Kinetics, 3rd. Edition, J.M. Smith, MGH.
3. Chemical Engineering Kinetics and Reactor Design, C.G. Hill, Wiley
4. The Engineering of Chemical Reactions, 2nd. Edition, L. D. Schmidt, Oxford
5. Experiments in Catalytic Reaction Engineering, J. N. Berty, Elsevier.

Separation Process - II - CHEN 3103

Module-I

Humidification & Dehumidification Processes: 10L

Introduction to Humidification and dehumidification operations, Characteristics of saturated and unsaturated vapor gas mixtures, Dry and wet bulb thermometry, Psychrometric chart, Adiabatic saturation curves, Psychrometric ratio, Gas liquid contact, Design of humidifiers, Dehumidification operation, Principle and design of cooling towers -Natural draft, forced draft and induced draft cooling towers.

MODULE-II

Liquid-Liquid Extraction & Leaching: 10l

Introduction to Extraction, Liquid- liquid equilibria, Triangular diagram, Selectivity and choice of solvents, Stage-wise contact, Co- current & counter-current extractor, Stage type extractors and differential extractors, Determination of number of equilibrium stages by graphical method for multistage extraction, Supercritical Fluid Extraction.

Introduction to leaching, General principle, Factors affecting the rate of extraction, Calculation of number of stages, Batch processes, Counter-current washing, Stage calculation methods.

MODULE-III

Drying & Crystallization: 10l

Introduction to drying, Rate of drying, Batch drying mechanism, Time of drying, the mechanism of moisture movement during drying, Classification and selection of dryer, Batch dryer and continuous dryer.

Introduction to crystallization, Theory of Crystallization, Formation and growth of crystals, Crystal yield, Rate of crystallization, Crystallizers.

MODULE-IV

Membrane Separation Processes: 10l

Introduction to membrane separation processes, Classification of membranes and membrane processes, Dialysis, Ultra filtration- Concentration Polarization, Application of Ultrafiltration Process, Reverse Osmosis, Reverse osmosis in water treatment plant, Pervaporation, Electrodialysis, Membrane fouling, Liquid membrane.

Text Books:

1. Mass Transfer Operations: Robert E. Treybal, McGraw Hill, International Student Edition, 1981.

2. Principles of Mass Transfer and Separation Processes, Binay K. Dutta, Prentice Hall of India, 2007.

3. Transport Process and Unit Operations: Christie J. Geankoplis. 3rd Edition., 1993, Prentice Hall of India.

References:

1. Separation Processes: King, C. J., McGraw Hill, Chemical Engineering Series.

2. Separation Process Principles, 3rd Edition, J.D. Seader, Earnest J. Henley, D. Keith Roper, 2010.

3. Unit Operations in Chemical Engineering: Mc Cabe and Smith, Harriot., McGraw Hill, Seventh Edition.

4.Coulson and Richardson's Chemical Engineering, Volume 2, Fifth Edition, J. F. ,Richardson and J.H. Harker with J.R. Backhurst, Pergamon Press.

5. Perry's Chemical Engineers' Handbook, , 8th Edition, McGraw Hill.

Numerical Methods of Analysis – CHEN 3104

Module I: **10L**
Approximation in numerical computation: Truncation and rounding errors, Fixed and floating-point arithmetic, Propagation of errors.
Interpolation: Newton forward/backward interpolation, Lagrange's and Newton's divided difference Interpolation.
Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Expression for corresponding error terms.

Module II: **10L**
Numerical solution of a system of linear equations: Gauss elimination method, Matrix inversion, LU Factorization method, Gauss-Seidel iterative method.

Bisection method, Secant method, Newton-Raphson method.

Module III: **10L**
Numerical solution of ordinary differential equation: Euler's method, Runge-Kutta methods, Predictor-Corrector methods.

Module IV: **10L**
Numerical Differentiation – Forward and Backward difference algorithms, First and Second order derivatives. Finite Difference methods for Boundary Value Problems, Parabolic PDEs.

Textbook:
Numerical Methods for Engineers – R. Chapra and S. Canale, Sixth Edition 6th Edition, McGraw-Hill Science/Engineering/Math, 2009.

Reference:
Mathematical Methods in Chemical Engineering – V.G. Jenson and G.V. Jeffreys, Academic Press, 2nd Edition.

Departmental Elective-I - CHEN 3131
Polymer Science & Engineering

Module I: 10 L
Definitions and concepts of terms used in polymer engineering, Classification of polymers; Polymer structures, functionality; polymerization reactions – mechanism of polymerization; stereospecific polymerization, copolymerization.
Introduction to nano-polymers: Characterisation techniques: XRD, FESEM and AFM

Module II: 10 L
Polymerization reactors, polymerization processes, characterization of polymers: DSC, DTGA, DMA, Creep Test analysis of polymerization reactions, polymer degradation.

Module III: 10 L
Molecular weight and molecular weight distribution in polymers, properties of polymers – physical, chemical, mechanical and electrical properties of polymers, elementary idea on polymer rheology, polymer blends.

Module IV: 10 L
Polymer processing: modeling – compression & transfer, injection & jet; casting; extrusion, calendaring, lamination, spinning & finishing.

Text Books:

1. Text Book of Polymer Science, 2nd Ed., F. W. Billmeyer, Jr., Wiley–Interscience, New York, 1971.
2. Polymer Science & Technology, P. Ghosh, Publisher: McGraw Hill Education (India) Private Limited; 3 edition (26 November 2010)

References:

1. The elements of Polymer Science & Engineering, Alfred Rudin, Academic Press, 2nd Edition, 1999
2. Introduction to Polymers, 2nd edition, by (second edition) *R. J. Young* and P. A. Lovell *Chapman* and *Hall, London*, 1991.

Departmental Elective-I - CHEN 3132
Petrochemical Technology

Module I **10L**

Evolution of petrochemical industry in India, recent trend of petrochemical industry in India, Petrochemical industry feedstock: overview of petroleum refinery industry and its product, natural gas processing; impurities in feedstock for petrochemical industry and the process of their removal.

Synthesis gas production and its use: Steam reforming operation of Naphtha and natural gas, fuel oil partial oxidation method, Methanol production, synthetic liquid fuel production by Fischer-Tropsch process, aldehyde and alcohol production from synthesis gas, ammonia production and its application.

Module II **10L**

Steam cracking operation of naphtha and C_2 to C_4 saturates, downstream separation scheme of naphtha cracking. Manufacture of Petrochemicals based on Ethylene: EDC, VCM, VAM, Ethylene oxide, Ethanol amine Manufacture of Petrochemicals based on Propylene: Acrylonitrile, Acrolein, Propylene oxide, glycerine (acrolein route, allyl chloride route, propylene oxide route), Isopropanol

Production of Butadiene from C_4 cut.

Module III **10L**

Catalytic reforming of naphtha, catalyst and process variable of BTX reformer, separation of Benzene, Toluene and Xylene from BTX reformate, pyrolysis gasoline hydrogenation and separation of aromatics, separation of meta xylene from mixed xylenes, alkylation of benzene, production of styrene, cumene and phenol, production of Phthalic anhydride. Synthetic detergent and its classication, production of linear alkyl beanzene and keryl benzene sulfonate from kerosene cut, additives for detergent.

Module IV **10L**

Overview of plastic industry: Production of LDPE, LLDPE, HDPE, PP, PVC, Polystyrene and their application.

Comparative study of Plastic, fibre and elastomer; production of SBR, Butadiene rubber, production of ABS plastic, polyamide, polyester, acrylic fibre, polycarbonates, production of phenol-formaldehyde resin; overview of polymer processing.

Text Books:

1. A Text on Petrochemicals: B.K.B. Rao, Khanna Publishers, 2011, ISBN 9788174090447 / 8174090444
2. Advanced Petrochemicals: Dr. G. N. Sarkar, Khanna Publishers, 2008, ISBN 8174090967
3. Introduction to Petrochemicals, Sukumar Maity. Oxford and IBH Publishing Co, 2002 ISBN 8120415558

References:

1. The Petroleum chemicals Industry: R. F. Goldstein and A. L. Waddams, E & F N Spon (An imprint of Routledge), 1967, ISBN 0419025308.
2. Petrochemical processes: Chauvel , Gulf Publishing Co, 1989, ISBN 0872017729.

Departmental Elective-I - CHEN 3133
Material Science & Engineering

Module - I: 10L

Structure of materials-Various types of bonds; Crystalline Structure of Solids- concepts of unit cell and space lattice, packing factor;

X-ray diffraction for determining crystal structure; Mechanical properties: Strength, hardness, toughness, ductility, brittleness of Engineering Materials**;** Elastic, Anelastic and visco-elastic behaviour of materials; Electrical, Electronic, Optical & Optoelectronic properties of material; Inorganic & organic amorphous materials and their structural & property characteristics; Optical fibers.

Module - II: 10 L

Mechanism of plastic deformation, slip and twinning, structural imperfections: elementary concepts of point, line, surface & volume imperfections; Influence of dislocations/Line imperfections on the mechanical properties of materials***;*** Strain hardening and recrystallisation; Elementary aspects of creep, fatigue, fracture; Phase Diagrams- Solidification and structure of metals, Grain boundaries; Phase equilibrium and phase diagrams of binary alloys; Phase diagram of ternary systems; Iron-Carbon diagram; Heat Treatment –Introduction and purposes of heat treatment; T-T-T diagram; Corrosion-Concepts and forms of corrosion; Corrosion Mechanism and prevention; Protective materials and coating.

Module – III: 10 L

Basic principles of metal extraction: Pyrometallurgy: Smelting, calcinations, roasting—oxidizing, predominance area diagrams, multiple hearth, flash and fluo-solid, sintering, smelting, slag and its classification.

Steelmaking process flow diagram: Iron making (Operation involved in Blast furnace)– Steel making (oxygen blown converter –LD) – Secondary steel making / refining (ladle processing, vacuum degassing, ladle furnace processing) – Continuous casting – with emphasis on application of the concepts of physicochemical principles involved, moving/packed bed reactor, gas-liquid two-phase flow, heat transfer with phase change (solidification).

Module - IV: 10 L

Principles of Hydrometallurgy and Electrometallurgy, Extraction of Aluminum: Hall-Heroult process, Electrolytic refining; Sources of Zinc & Copper: Pyro & Hydro metallurgical extraction of copper & Zinc; Extraction of Lead, Recent development in Lead smelting.

Text Books:

1. Raghavan, V. Material Science and Engineering, (5th Edition) *V. Raghavan Prentice-Hall of India* Pvt. Ltd., 2004;
2. Ray, Sridhar & Abraham. Extraction of non ferrous metal, 1985, *EWP*, New Delhi. Sevryukov N.,

References:

1. Elements of Material Science and Engineering, by Lawrence, H. Vanvlack; Published by *Pearson Education*, 1980.
2. Engineering Physical metallurgy; *Lakhtin*, Y. Published by *MIR Publishers*, Moscow, 1975.
3. The Reduction of Iron Ores, by L. Von Bogdandy and H.J Engell Published by Springer- Verlag, New York.
4. Engineering in Process Metallurgy, by R.I.L Guthrie Oxford University Press (Paperback edition 1992).

Mass Transfer laboratory - CHEN 3111
At least eight experiments are to be performed

LIST OF EXPERIMENTS:

1. Study of simple batch distillation to verify Rayleigh's equation.
2. Experiment on wetted wall column to determine mass transfer co-efficient.
3. To study the performance of a distillation (sieve tray/ bubble cap) column.
4. To study gas absorption in a packed tower to determine volumetric mass transfer coefficient and is variation with change in liquid rate.
5. To study the drying rate characteristics curve under constant drying condition in a tray dryer.
6. Experiment on batch adsorption and verification of adsorption isotherms.
7. Experiment on liquid-liquid extraction (to determine the overall mass transfer coefficient for counter current operation)
8. To study drying characteristics in a Rotary Dryer.
9. Determination of psychrometric properties air-water vapour system.
10. To determine the diffusivity of a volatile solid in gas.
11. Determination of diffusivity of volatile liquids in air using Stefan tube.

PEDD- I - CHEN 3112

1. Design and Drawing Pressure Vessel - thin and thick cylinder design, design of cylinder head, cover plate, selection of gasket, design of bolt and flange.
2. Design and Drawing of Reactor.

Each student shall be allotted design problems on sl. no 1& 2 at the beginning of the 5th semester and the student shall carryout complete process and mechanical design under supervision of a faculty. The student shall also prepare engineering drawing of the equipment and submit two copies of the design report in tight and bound form 7 days before commencement of 5th semester examination. Assessment would be made on the basis of the submitted report and the viva voce examination conducted by a board of examiners constituted by the Departmental Academic Committee consisting of two faculty members and class teachers with Head of the Department as Chairman during 5th. Semester examination.

Text Book / References:

1. Process Equipment Design – Brownell and Young, John Wiley and sons.
2. Chemical Engineering Design, Fourth Edition: Chemical Engineering Volume 6 (Coulson & Richardson's Chemical Engineering) 4th Edition - by R K Sinnott (Author), Butterworth-Heinemann; 4 edition.

Chemical Reaction Engineering Laboratory - CHEN 3113
At least eight experiments are to be performed

1. Experimental studies on kinetics of a non catalytic homogeneous liquid phase reaction in an isothermal batch reactor
2. Experimental studies on kinetics of a homogeneous liquid phase reaction in an isothermal semi batch reactor
3. Experimental studies on kinetics of a non catalytic homogeneous liquid phase reaction in a Spiral plug flow reactor.
4. Experimental studies on kinetics of a non catalytic homogeneous liquid phase reaction in an isothermal CSTR.
5. Experimental studies on kinetics of a non catalytic homogeneous liquid phase reaction in a packed bed reactor.
6. Experimental studies on RTD in a tubular PFR using pulse input of tracer and measurement of axial dispersion coefficient.
7. Experimental studies on kinetics of a heterogeneous catalytic reaction in a UV photoreactor.
8. Experimental studies on RTD in a packed bed reactor using pulse input of tracer and measurement of axial dispersion coefficient.
9. Experimental studies on kinetics of hydrolysis of ethyl acetate in presence of acid catalyst in an adiabatic batch reactor.
10. Experimental studies on kinetics of sulfonation of toluene in an isothermal batch reactor.

Process Dynamics, Instrumentation and Control - CHEN 3201

Module 1: 10 L

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

Temperature measurement: Filled system Thermometer, Thermocouples, Resistance Thermometers, radiation and optical pyrometers;

Pressure: Manometers: U tube manometer, inclined limb manometer, Ring balance manometer, Elastic deformation: bourdon, bellows, diaphragm and electrical type gauges: strain gauge, piezoelectric, pressure transducers.

Vacuum gauges: mechanical, electrical and ionization types;

Flow: Head flow meters, area flow meters, positive displacement flow meters, mass and magnetic flow meters;

Level: Direct and inferential type; composition.

Module 2: 10L

Introduction to process control, Use of Laplace transforms in process control, Different forcing functions: Step, Pulse, Impulse, Ramp, Sinusoidal and frequency inputs & their graphical representation.

First order system; Transfer function; Examples of First Order Systems, Pure capacitive system, Response of different forcing functions; First order systems in series- non- interacting & interacting. Second order system- Under- damped, critically damped & over damped, Second order system examples - Damped vibrator, Control valve, U-tube manometer, terms related to under damped system, Transportation lag.

Module 3: 10 L

Feedback control loop and its components, advantages and disadvantages of feedback control system

Simple process models and their transfer functions**:** stirred tank heater, continuous stirred tank reactor, heat exchanger, distillation column, U-tube manometer

State-space representation of linear systems

Different types of controllers and their applications: P, PI, PD, PID & their transfer function, servo and regulatory control, transient responses of feedback control systems

Block diagram: Block diagram of different chemical process units, block diagram reduction, open loop & closed loop transfer function, concept of poles and zeros

Control valves: construction, types of control valves, characteristic curves & transfer function, valve sizing, applications

Elementary idea of feed forward, cascade, ratio control.

Module 4: 10L

Definition of stability, concept of bound and unbound function

Stability Analysis of Feedback control systems: Routh-Hurwitz stability criterion, Direct Substitution method, Root Locus Analysis, Frequency response analysis, Bode plot and Bode stability criterion, Nyquist stability criteria.

Performance Criteria for good control (ISE, ITAE, IAE etc), concept of empirical process models, development of empirical process models: FOPDT, SOPDT etc and evaluation of their performance, Process reaction curve method, Zeigler-Nichols and Cohen Coon controller tuning rules, and determination of controller settings.
Adaptive & digital control, concept of PLC & DCS.

Text books:

1. Process system analysis & Control-D.R. Coughanowr, McGraw-Hill, Inc., 2nd ed., 1991.
2. Chemical Process Control: An Introduction to Theory and Practice-George Stephanopoulos, pHI, 1st ed., 1984.
3. Industrial Instrumentation-D. P. Eckman, Wiley Eastern Ltd., 1st ed., 2004.

References:

1. Principles of Industrial Instrumentation-D. Patranabis, Tata McGraw Hill, Publishing Ltd., 1st ed., 1999.
2. Process Dynamics and Control-D.E. Seborg, T.F. Edgar, and D.A. Mellichamp, John Wiley & Sons,2nd ed., 2004.
3. Industrial Instrumentation Fundamentals-A.E. Fribance, McGraw-Hill, Kogakusha, 1962.
4. Process Control Modelling, Design and Simulation-B. Wayne Bequette, Prentice Hall, 1957.
5. Process Modelling, Simulation and Control for Chemical Engineers-William L. Luyben, McGraw Hill, 1990.

Project Engineering -- CHEN 3202

Module 1: 10 L

Role of a Project Engineer, Development of Laboratory bench scale experiment to pilot & semi-commercial plant operation, scale up and scale down techniques, pre-design cost estimations, fixed capital and working capital, manufacturing cost, plant location and plant lay out, plant utilities, safety measures.

Time value of money, simple interest, nominal and effective interest rates, compound and continuous interest, present worth and discount, annuity, perpetuity and capitalized costs, Pay out period.

Module 2: 10 L

Depreciation: Types of depreciation, Depletion, concepts of service life, salvage value, and book value, straight-line method, Declining balance method, sum of the years digit method and sinking fund method for determination of depreciation, modified accelerated cost recovery system (MACRS),

Alternative investment, Choices among various alternatives, Replacements, Methods of profitability evaluation for replacements, Return on investment, Net present worth (NPW), Discounted cash flow rate of return (DCFR), Effect of inflation on profitability, income taxes, GDP and national growth..

Module 3: 10 L

Optimum Design and Design strategy: Basic principle of Optimum Design, general procedure for determining optimum conditions, Breakeven analysis, Optimum production rate in plant, determination of optimum economic pipe diameter and optimum flow rate in condenser, minimum cost analysis, economics in selection of materials.

Basic concepts of process integration, Pinch analysis

Module 4: 10 L

Project scheduling: Bar chart, Milestone chart, Concept of network analysis: Numbering network, PERT, CPM, statistical distribution associated with PERT network, Earliest expected time and latest allowable occurrence time calculation, Slack, determination of critical path, concept of float.

Text Book

1. Plant Design and Economics for Chemical Engineers -- Peters and Timmerhaus and West, Mc Graw Hill, 5th Ed., 2003
2. PERT and CPM – Principles and Applications, Affiliâted East West, 3rd Ed., 1989

References:

1. Chemical Engineering Design – Coulson and Richardson, Volume 6, Elsevier, 5th Ed., 2009

Chemical Process Technology II - CHEN 3203

Module 1 : 10 L

Oils and Fats : Elementary idea, Composition (Fatty acid profile), Methods of extracting vegetable oils; Hydrogenation of oils, Major engineering problems and improved technology; Transesterification and Interesterification through enzymatic route; their applications.

Soaps, Detergents & Glycerin : Classification of cleansing compounds, uses; Methods of soap production, Methods of detergent manufacture, Methods of production of Glycerin (Process description and flow sheet of each process).

Module 2: 10 L

Sugar and starch industries: Manufacturing process of sugar with flow diagram, Sugar refining, Manufacturing process of starch and their different by-products; Glucose, Sorbitol and Polyols.

Fermentation industries: Industrial alcohol, Absolute alcohol, their production processes with flow diagram.

Agrochemical industries: Elementary ideas on Pesticides, Insecticides, Fungicides, Herbicides, DDT manufacturing process with flow sheet.

Module 3: 10 L

Organic synthesis: nitration, sulfonation, amination, halogenation, hydrolysis with examples. Petrochemicals: Methanol, Vinyl chloride, Ethylene oxide, Isopropanol, Butadiene, Phenol and Pthalic anhydride – their manufacturing process with flow diagram and engineering problems

Paints & pigments: Domestic and industrial paints- their compositions including ingredients and additives in relation to their applications – Paint manufacturing processes.

Module IV: 10L

Polymerisation: Principles of polymerization, Different methods of polymerization, manufacturing process and flow diagram for Polyethylene, PVC and Phenol formaldehyde. Rubber industry: Natural and synthetic rubber (SBR, Butyl rubber). Synthetic Fibre industry: Rayon, Nylon, Terelyne – Methods of production and flow diagrams.

Polymer forming processes- their suitability for the type of polymer feedstock and the size and shape of the products.

Text books:

1. Shreve's Chemical Process Industries – R. N. Shreve, G. T. Austin, McGraw Hill, Ed. 5, 1984.

2. Dryden, C. E., and Rao, M.G. (Ed.), Outlines of Chemical Technology Affiliated East West Press

References:

1. Enzymes in Food Processing: Fundamentals and Potential Applications – P. S. Panesar, S. S. Marwaha, H. K. Chopra, I. K. international Publishing House Pvt. Ltd., 2010.

Mathematical Methods in Chemical Engineering - CHEN 3204

Module I 10L

Solution of linear algebraic equations; Matrix series; Differentiation & Integration of matrix; Lamda matrix; Characteristics equation; Eigenvalue Problem; Solution of systems of linear differential equations by matrix. Representation of the problems: Solvent extraction in two stages, Solvent extraction in N stages, Simple water still with preheated feed, unsteady state operations; Dependent and Independent variables and parameters; boundary conditions.

Linear & simultaneous differential equations, related problems. Series and parallel reactions in CSTR.

Module II 10L

Solution by series: Introduction; Infinite series; Power series; Method of Frobenius and Related problems: Temperature distribution in a transverse fin, Tubular gas preheater; Bessel's Equation, Problem of heat loss through pipe flanges, properties of Bessel function.

Module III: 10L

Partial differentiation & Partial Differential Equations: Introduction; Interpretation of partial derivatives, Formulation of partial differential equations; Boundary conditions; Particular solutions of partial differential equations; Orthogonal functions; Method of separation of variables; Laplace transform method.

Module IV: 10L

Boundary layer theory; Applications in Laminar Flow along a flat plate; Forced Convection heat transfer in a sphere in creeping flow. Diffusion and Chemical reaction in isothermal laminar flow along a flat plate.

Textbook:

1. Mathematical Methods in Chemical Engineering – V.G. Jenson and G.V. Jeffreys, Academic Press, 2nd Edition
2. Advanced Engineering Mathematics - Michael D. Greenberg, Pearson Publisher 1998.
3. Transport Phenomena - R. Byron Bird, Warren E. Stewart and Edwin N. Lightfoot, John Wiley & Sons, Inc, 2nd edition, 2006.

Departmental Elective II - CHEN 3231
Nanotechnology

Module 1 (10 L):

Introduction to the physics of solid state; Structure & Bonding.

Elements of nanoscience & nanotechnology.

Module 2 (10 L):

Synthesis of nanomaterials: General approaches, Physical Methods, Chemical Methods & Biological Methods;

Properties of nanomaterials: Mechanical, Structural, Thermal, Electrical & Optical properties.

Module 3 (10 L):

Characterization techniques of nanomaterials: Microscopy; Spectroscopy; & Diffraction techniques; Some special nanomaterials: Carbon nanotubes, Porous silicon, Zeolites, Aerogels, Core-shell nanoparticles.

Module4 (10 L):

Application: Nanolithography, Nanocomposites, Nanoparticles as catalyst, conducting polymers; nanotechnology: DNA Nanowires, Nanomedicines.

Text book:

1. NANOTECHNOLOGY: Principles & Practices; Sulabh K. Kulkarni, Springer International Publishing, 2015

Departmental Elective - II CHEN 3232
Computational Fluid Dynamics

Module 1 (10 L):

Conservation Principles – Convervation of Mass, Momentum, Energy in dimensional and non-dimensional forms – Lagrangian and Eulerian forms ; Conservative and Non-conservative forms of transport equations ; Equations – Elliptic, Parabolic and Hyperbolic Understanding the convection and diffusion terms ; Generalized Advection-Diffusion Equation with source term Initial condition and Boundary conditions (three kinds).

Module 2 (10 L):

Concept of discretization – Taylor series FDM and CV based FVM – one-dimensional unsteady state heat diffusion equation - Treatment of boundary conditions; Numerical solution of PDE - Explicit method – Stability – Convergence – Consistency ; Direct Method - Thomas (Tri-diagonal Matrix) Algorithm. Iterative method - ADI method. Coupled Equation and Their Solution.

Module 3 (10 L):

Interpolation in Finite Volume Methods. Discretization of the convection term - Upwind scheme - Central Difference scheme - Hybrid scheme - Power law scheme. Special Featuers of the Navier Stokes Equation - Discretization of Convective and Viscous Terms, Discretization of Pressure Terms and Body Forces. Arrangment on Grid – Colocated and Staggered Arrangement. Multigrid Methods.

Module 4 (10 L):

Methods for Unsteady Problems. Calculation of Pressure – Explicit and Implicit Time Advance Schemes. Pressure Correction Methods.

Evaluation of pressure from Equation of Continuity ; Velocity correction ;SIMPLE Algorithm – Residues in solution – Relaxation Iterative scheme – Over and under relaxation - quick updation ; Discussion on SIMPLER, SIMPLE-C.

Other methods – Artificial Compressibility method.

Test Books/ References:

1. Numerical Heat Transfer and Fluid Flow: S V Patankar. Taylor & Francis (Paperback Ed)
2. Computational Fluid Mechanics and Heat Transfer: J C Tannehill, D A Anderson and R H Pletcher. Taylor &
Francis (1997)
3. Computational Methods for Fluid Dynamics: J H Ferziger and M Peric. Springer-Verlag (1999)

Departmental Elective - II CHEN 3233
Bioprocess Engineering

Module I (10 L)

Principles of enzyme catalysis Proteins as enzymes; Michaelis-Menten kinetics; Briggs Halden theory Kinetics and Statistics; Inhibition; Effect of pH and temperature; Enzymology; methods of immobilization, diffusional limitations in immobilized enzyme systems.

Module II (10 L)

Microbial growth Introduction to metabolism; Nutrient transport; Glycolysis; TCA cycle and other pathways; Control of metabolism; Factors affecting microbial growth; Stoichiometry: mass balances; Stoichiometry: energy balances; Growth kinetics; Measurement of growth.
Agitation and aeration**:** types of impellors and sparger, oxygen transfer rate, oxygen uptake rate, volumetric oxygen transfer rate (kLa), measurement of k_La, power requirement for agitation in gaseous and non gaseous systems.

Module III (10L)

Bioreactors Introduction to bioreactors; Batch and Fed-batch bioreactors, Continuous bioreactors; Immobilized cells; Bioreactor operation; Sterilization; Aeration; Sensors; Instrumentation; Culture-specific design aspects: plant/mammalian cell culture reactors.
Scale up, operation and control of bioreactors**:** Concepts of various bioreactor configurations, scale-up, various criteria for scale-up, scale-down, bioreactor instrumentation and control.

Module IV (10 L)

Bioseparations Biomass removal; Biomass disruption; Membrane-based techniques; Extraction; Adsorption and Chromatography.
Industrial Processes and Process economics Description of industrial processes; Process flow sheeting; Process economics.

Texts/References:

1. Michael Shuler and Fikret Kargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ, 2002.
2. Pauline Doran, Bioprocess engineering principles, 1 Edition, Academic Press, 1995.
3. Biochemical Engineering, Marcel Dekkar, Inc, 2007
4. Roger Harrison et al., Bioseparations Science and Engineering, Oxford University Press, 2003.

Principles of Management (HMTS-3201)

2L/Week Credit-2

Module 1:

Management: Definition, nature, purpose and scope of management, Skills and roles of a Manager, functions, principles; Evolution of Management Thought: Taylor Scientific Management, Behavioral Management, Administrative Management, Fayol's Principles of Management, Hawthorne Studies. **(4L)**

Module 2:

a) **Planning:** Types of plans, planning process, Characteristics of planning, Traditional objective setting, Strategic Management, premising and forecasting.

b) **Organizing:** Organizational design and structure, Coordination, differentiation and integration.

c) **Staffing:** Human Resource Management and Selection, Performance appraisal and Career strategy, Managing Change.

d) **Decision-Making:** Process, Simon's model of decision making, creative problem solving, group decision-making.

e) **Coordinating:** Concepts, issues and techniques.

f) **Controlling:** Concept, planning-control relationship, process of control, Types of Control, Control Techniques (**8L)**

Module 3:

Span of management, centralization and de-centralization Delegation, Authority & power - concept & distinction, Line and staff organizations. **(4L)**

Module 4:

Organization Behaviour: Motivation, Leadership, Communication, Teams and Team Work**. (6L)**

Management by Objectives (MBO): Management by exception; Styles of management: (American, Japanese and Indian), McKinsey's 7-S Approach, Self Management. **(2L)**

Evaluation:

Max. Marks-100

Internal Test-30

Semester End Test-70

Suggested Readings:

1. Harold Koontz & Heinz Weihrich, Essentials of Management, TMH.
2. Stoner, Freeman, Gilbert Jr., Management, PHI.
3. Bhatt & Kumar, Principles of Management, OUP.

PEDD II - CHEN 3211

1. Design and Drawing of Heat Exchanger.

2. Design and Drawing of Orifice meter / Venturi meter/ Rotameter (Anyone).

Text Book / References:

1. Process Equipment Design – Brownell and Young, John Wiely and sons.
2. Chemical Engineering Design, Fourth Edition: Chemical Engineering Volume 6 (Coulson & Richardson's Chemical Engineering) 4th Edition - by R K Sinnott (Author), Butterworth-Heinemann; 4 edition.

Numerical Methods Laboratory – CHEN 3212

Module- I: Numerical Methods (Programming language: Matlab)

1. Solution of Linear System by Gauss Elimination method and Gauss-Seidel iterative method: Steadystate solution of isothermal CSTR in Series in which a first-order reaction is taking place.
2. Solution of a non-linear equation by Newton-Raphson method.
3. Solution of a set of non-linear equations by Newton method: steady-state solution of a non-isothermal CSTR in which a first-order reaction is taking place.
4. Solution of one-dimensional unsteady state heat conduction problem using Taylor series based Finite Difference Method – Explicit scheme, Implicit scheme using Tri-diagonal Matrix Algorithm (TDMA).
5. Numerical solution of ODEs by Runge-Kutta method : Unsteady-state solution of Multiple reactions in a CSTR or Binary distillation column.

Personality Development - HMTS 3221

1L/week Credit 1

Module 1

Self-Growth

i)Self Growth- Maslow's Hierarchy of Needs Theory

ii) Anger, Stress & Time Management- Theories and application

iii) SWOT Analysis

Module II

Stepping Up

i) Growth & Environment

ii) Competitive Spirit

iii) Responsibility Factor

Module III

Professional Communication

i) Impression Management- theory on social psychology

ii) Employability Quotient

iii) Cross-cultural communication

Module IV

Leadership & Team Playing

i) Leadership & Team Playing: Theories, Styles, Stages

ii) Motivation, Negotiation Skills, Conflict Management

iii) Planning & Envisioning: Initiative and Innovation in the Work Environment- De Bono's Six Thinking Hats

Methodology: Assignment and project

Suggested Reading

1. Personality Development and Soft Skills by Barun K. Mitra, Oxford University, 2011

2. Soft Skills: An Integrated Approach to Maxmise Personality by Gajendra Singh Chauhan and Sangeeta Sharma, Wiley, 2016

3. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success by Gopalaswamy Ramesh and Mahadevan Ramesh, Pearson, 2010