SIR PADAMPAT SINGHANIA UNIVERSITY

Udaipur

SCHOOL OF ENGINEERING

Course Curriculum of 4-Year B. Tech. Degree Programme in Chemical Engineering (Batch- 2018-22)

Credit Structure

B. Tech. Core		B. Tech. Elective	
Category	**Credits**	**Category**	**Credits**
Departmental Core Subjects	123	Departmental Electives	9
Humanities & Basic Sciences Subjects	36	Open Electives	13
Management Subjects	2		
Total	161	Total	22
		Grand Total	183

Distribution of Total Credits & Contact Hours in all Semesters

S. No.	Semester Number	Credits/Semester	Contact hours/week
1	I	21	25
2	II	22	27
3	III	22	23
4	IV	22	23
5	V	24	27
6	VI	23	25
7	VII	30	29
8	VIII	19	24
	Total	183	--

Course Structure: B. Tech. 2018-22

Semester - I

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	CE-151	Engineering Mechanics	3	1	0	4
2	ME-151	Engineering Drawing & Computer Aided Drafting	0	1	1	2
3	ME-152	Manufacturing Practices	0	0	1	1
4	HU-153	Professional Communication – I	2	0	0	2
5	CH-154	Chemistry – I	3	0	1	4
6	MA-151	Mathematics – I	3	1	0	4
7	PH-151	Physics – I	3	0	1	4
					Total Credits	21
8	EP-199	Endeavour Project (Beyond the Syllabus)				
					Total Contact hours/week	25

Semester - II

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	CS-152	Introduction to Computers & Programming	2	0	2	4
2	EC-152	Basics of Electrical & Electronics Engineering	3	0	1	4
3	HU-154	Professional Communication – II	1	1	0	2
4	CH-155	Chemistry – II	3	0	1	4
5	MA-152	Mathematics – II	3	1	0	4
6	PH-152	Physics – II	3	0	1	4
					Total Credits	22
7	EP-199	Endeavour Project (Beyond the Syllabus)				3
					Total Contact hours/week	27

Semester - III

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	CM-251	Introduction to Chemical Engineering	3	1	0	4
2	CM-252	Material Science	3	1	0	4
3	CM-253	Chemical Process Calculations	3	1	0	4
4	CE-254	Fluid Mechanics – I	3	0	1	4
5	HU-251	Business & Technical Communication	0	2	0	2
6	MA-251	Introduction to Algebra & Matrix Analysis	3	1	0	4
					Total Credits	22
7	EP-299	Endeavour Project (Beyond the Syllabus)				
					Total Contact hours/week	23

Semester - IV

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	CM- 254	Heat Transfer	3	1	0	4
2	CM-255	Chemical Engineering Thermodynamics	3	1	0	4
3	CM-256	Chemical Reaction Engineering	3	1	1	5
4	BT-269	Environmental Biotechnology	3	0	0	3
5	ME-261	Fluid Mechanics - II	3	1	0	4
6	XX-XXX	Open Elective – I	X	X	0	2
					Total Credits	22
7	EP-299	Endeavour Project (Beyond the Syllabus)				3
					Total Contact hours/week	23

Semester - V

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	CM-351	Mechanical Operation	3	1	0	4
2	CM-352	Fundamental of Bioenergy	3	1	0	4
3	CM-353	Mass Transfer – I	3	1	0	4
4	CM-354	Instrumentation & Process Control	3	1	1	5
5	BT-353	Bioprocess Engineering	2	1	2	5
6	XX-XXX	Open Elective – II	X	X	0	2
					Total Credits	24
7	EP-399	Endeavour Project (Beyond the Syllabus)				
					Total Contact hours/week	27

Semester - VI

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	CM-355	Chemical Process Technology	3	1	0	4
2	CM-356	Mass Transfer – II	3	1	0	4
3	CM-357	Computer Aided Process	3	1	0	4
4	CM-358	Fuel Technology	3	0	2	5
5	CM-3XX	Departmental Elective – I	3	0	0	3
6	CM-3XX	Departmental Elective – II	3	0	0	3
					Total Credits	23
7	EP-399	Endeavour Project (Beyond the Syllabus)				3
					Total Contact hours/week	25

Semester - VII

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	CM-451	Transport Phenomena	3	1	0	4
2	CM-452	Mineral Beneficiation	3	1	0	4
3	CM-453	Process Equipment Design	3	1	0	4
4	CM-4XX	Departmental Elective – III	3	0	0	3
5	CM-450	Summer Internship	-	-	-	3
6	CM-455	Comprehensive Viva Voce	-	-	-	2
7	CM-460	Minor Project	0	0	3	3
8	HU-451	Interview Skills	0	0	1	1
9	MA-454	Quantitative Aptitude	0	1	0	1
10	BM-451	Ethics & IPR	2	0	0	2
11	XX-XXX	Open Elective – III	3	0	0	3
					Total Credits	30
12	EP-499	Endeavour Project (Beyond the Syllabus)				
					Total Contact hours/week	29

Semester - VIII

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	CM-454	Process Dynamic & Control	3	1	1	5
2	CM-456	Biochemical Technology	3	1	0	4
3	CM-470	Major Project	0	0	4	4
4	XX-XXX	Open Elective – IV	3	0	0	3
5	XX-XXX	Open Elective – V	3	0	0	3
					Total Credits	19
6	EP-499	Endeavour Project (Beyond the Syllabus)				3
					Total Contact hours/week	24

List of Departmental Elective(s) - I

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	CM-359	System Engineering	3	0	0	3
2	CM-360	Non-Conventional Energy Sources	3	0	0	3

List of Departmental Elective(s) - II

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	CM-361	Green Technology	3	0	0	3
2	CM-362	Polymer Engineering	3	0	0	3

List of Departmental Elective(s) - III

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	CM-457	Industrial Pollution Control	3	0	0	3
2	CM-458	Fundamental of Bioenergy	3	0	0	3

List of Open Elective(s) - I

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	HU-252	Language through Literature & Films	0	2	0	2
2	BM-270	Foundations of Economic Science	2	0	0	2

List of Open Elective(s) - II

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	HU-351	Fun with Drama	0	2	0	2
2	BM -370	Marketing Management	2	0	0	2

List of Open Elective(s) - III

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	BT-471	Bioprocess Technology	3	0	0	3
2	CE-462	Air Pollution & Industrial Waste Management	3	0	0	3
3	CM-459	Hazard Analysis & Risk Management in Chemical Industry	3	0	0	3
4	CS-462	Management Information Systems & E-Commerce	3	0	0	3
5	EE-465	Energy Conversion Process	3	0	0	3
6	ME-465	Solar Energy & Applications	3	0	0	3
7	PH-451	Nanotechnology	3	0	0	3
8	PH-453	Chaos in Engineering System	3	0	0	3

List of Open Elective(s) - IV

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	BT-475	Bioremediation Technology	3	0	0	3
2	CE-464	Environmental Management	3	0	0	3
3	CS-459	Statistical Simulation & Data Analysis	3	0	0	3
4	EC-473	Robotics & Automation	3	0	0	3

List of Open Elective(s) - V

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	BT-472	Bioelectronics & Biosensors	3	0	0	3
2	CS-461	Soft Computing	3	0	0	3
3	EE-466	Hydro Power Generation	3	0	0	3
4	MA-453	Mathematical Statistics	3	0	0	3
5	ME-467	Total Quality Management	3	0	0	3

Detailed Syllabus for B. Tech. Degree Programme in Chemical Engineering

Semester - I

(Departmental Core Subject)

CE-151 L-T-P-C
Engineering Mechanics 3-1-0-4

Objective: *The subject deals with the concepts of static & dynamic systems involving kinematic & dynamic analysis.*

Course Content

Basic principles: Equivalent force system; Equations of equilibrium; Free body diagram; Reaction; Static indeterminacy. Structures: Difference between trusses, frames & beams, Assumptions followed in the analysis of structures; 2D truss; Method of joints; Method of section; Frame; Simple beam; types of loading & supports; Shear Force & bending Moment diagram in beams; Relation among load, shear force & bending moment. Friction: Dry friction; Description & applications of friction in wedges, thrust bearing (disk friction), belt, screw, journal bearing (Axle friction); Rolling resistance. Virtual work & Energy method: Virtual Displacement; Principle of virtual work; Applications of virtual work principle to machines; Mechanical efficiency; Work of a force/couple (springs etc.); Potential energy & equilibrium; stability. Center of Gravity & Moment of Inertia: First & second moment of area; Radius of gyration; Parallel axis theorem; Product of inertia, Rotation of axes & principal moment of inertia; Moment of inertia of simple & composite bodies. Mass moment of inertia. Kinematics of Particles: Rectilinear motion; Curvilinear motion; Use of Cartesian, polar & spherical coordinate system; Relative & constrained motion; Space curvilinear motion. Kinetics of Particles: Force, mass & acceleration; Work & energy; Impulse & momentum; Impact problems; System of particles. Kinematics & Kinetics of Rigid Bodies: Translation; Fixed axis rotational; General plane motion; Coriolis acceleration; Work-energy; Power; Potential

energy; Impulse-momentum & associated conservation principles; Euler equations of motion & its application.

Text/Reference Books

1. Engineering Mechanics: Statics and Dynamics. Shames I. H. 4th Ed. PHI. 2002.
2. Engineering Mechanics. Vol I - Statics, Vol II - Dynamics. Meriam J. L. &Kraige L. G. 5th Ed. John Wiley. 2002.
3. Engineering Mechanics. Vol. I and II. Hibbler R. C. Pearson Press. 2002.

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Semester- I

(Departmental Core Subject)

ME-151 L-T-P-C
Engineering Drawing & Computer Aided Drafting 0-1-1-2

Objective: *Engineering drawing is a visual language of an engineer. It permits students to convert an object into its visual representation.*

Course Content

Importance of engineering drawing; Conventions & standards: ISO; Scales; Curves; Orthographic projections : points, lines, planes & solids; Sections of solids; Isometric projections; Development of surfaces; Intersection of solids.

List of Experiments

1. Introduction to Engineering Graphics, Sheet Layout, instruments, BIS standards, Lines, Lettering & Dimensioning
2. Scales -Types of Scales-Plain Scale, Diagonal scale, vernier scale
3. Curves- conic sections, ellipse, parabola, hyperbola, cycloid, epicycloid, hypocycloid
4. Orthographic Projections-Introduction, multi-view projection system, orthographic views, Methods of multi-view projections, projecting side views, Sectional Views
5. Projection of Points -Introduction, position of points in I, II, III & IV quadrant
6. Projection of Lines & Auxiliary projections-, Line inclined to one plane & parallel to the other-Line inclined to both the planes. Projection on auxiliary planes
7. Projection of Planes- Introduction, Perpendicular & parallel to the reference planes Projections of planes inclined to one reference plane & perpendicular to the other, plane inclined to both ref. planes

8. Projection of solids with axes inclined to one of the reference plane & parallel to the other
9. Fundamentals of 2-D, Drawing & Edit commands. Draw 2D& 3D object drawing
10. Section of Solids- Sections of prisms, pyramids, cone cylinder
11. Development of Surfaces- Methods of development-Cube, prisms, pyramids, cone cylinder
12. Intersection of Surfaces- Line method-cutting plane method, Intersection of two prisms- Intersection of cylinder & cylinder
13. Isometric Projection- Isometric axes lines & planes, Isometric Scale, Isometric views of standard shapes, solids

Text/Reference Books

1. Engineering Drawing. Dhananjay A.J. Tata McGraw-Hill. 2008
2. Engineering Drawing. Bhatt N. D. &Panchal V.M. 43th Ed. Charator Publishing House. 2001.
3. Engineering Drawing. Shah M. B. &Rana B. C. 2nd Ed. Pearson Education. 2009.
4. Graphic Science and Design. French T. E., Vierck C. J. & Foster R. J. 4th Ed. McGraw-Hill. 1984.
5. Fundamentals of Engineering Drawing. Luzadder W. J. & Duff J. M. 11th Ed. PHI. 1995.
6. Engineering Drawing and Graphics. Venugopal K. 3rd Ed. New Age International. 1998.

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Semester - I

(Departmental Core Subject)

ME-152 L-T-P-C
Manufacturing Practices 0-0-1-1

Objective: *This course is intended to impart basic knowledge of various hand tools & their usage in different sections of manufacturing; including Carpentry, Fitting, House wiring, Black smithy, Tin smithy.*

List of Experiments

1. Demonstration of the manufacturing practices, workshop safety, trades, tools, experiments
2. Measurement of the dimensions of a given job using precision instruments
3. Fabrication of a fitting job with drilling & tapping of a hole
4. Preparation of a funnel with spout as per drawing from 30 SWG. G.I sheet. Joints to be soldered with the soldering iron
5. Fabrication of a T-half lap joint & T-bridle joint
6. Preparation of a wooden patterns as per given drawings
7. Preparation of a mould for a given wooden pattern
8. Preparation of an aluminum casting with the help of a given wooden pattern

Text/Reference Books

1. Elements of Workshop Technology-Vol. I. Choudhury H. Asia Publishing House. 1986.
2. All About Machine Tools. Gerling H. New Age International. 1995.
3. Workshop Technology. Chapman W. A. J. Oxford IBH. 1975.

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Semester - I

(Humanities & Basic Sciences Subject)

HU-153	L-T-P-C
Professional Communication - I	2-0-0-2

Objective: *To develop communicative competence.*

Course Content

Communication: Importance of effective communication skills, Objectives & Process of communication; Types of communication: Verbal & non-verbal; Channels of communication, Media of communication; Barriers to communication: Physical, Psychological, Mechanical, Linguistic & Cultural; Types of listening, Principles of effective listening.

Word Power: Words often misspelt, One word substitute, Use of idiomatic expressions & phrases.

Time & Stress Management: Planning, Scheduling & Prioritizing, Multitasking, Delegating; Saying no assertively; Stress & its causes, Barriers to stress management & Handling stress.

Text/Reference Books

1. Technical Communication. Raman M. & Sharma S. Oxford University Press. 2004.
2. Essentials of Business Communication. Pal R. & Korlahalli J. Sultan Chand & Sons. 2011.
3. Word Power Made Easy. Lewis N. 2nd Ed. Goyal Publisher. 2011.

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Semester - I

(Humanities & Basic Sciences Subject)

CH-154 L-T-P-C
Chemistry - I 3-0-1-4

Objective: *The subject deal with the concepts related to Physical chemistry & develops a scientific attitude by means of distinguishing, analyzing & solving various engineering problems. It also provides in-depth knowledge of thermodynamics, quantum chemistry, chemical kinetic, corrosion & colloids.*

Course Content

Concept of Thermodynamic system: Definition with example of di thermal wall, adiabatic wall, isolated system, closed system, open system, extensive property, intensive property. Introduction to first law of thermodynamics: different statements, mathematical form. Internal energy: Definition, Example, Characteristics, Physical significance, Mathematical expression for change in internal Energy, Expression for change in internal energy for ideal gas. Enthalpy: Definition, Characteristics, Physical significance, Mathematical expression for change in Enthalpy, Expression for change in enthalpy for ideal gas. Heat Capacity**:** Definition, Classification of Heat Capacity (Cp&Cv): Definition & General expression of Cp - Cv. Expression of Cp - Cv for ideal gas. Reversible & Irreversible processes: Definition, Work done in Isothermal Reversible & Isothermal Irreversible process for Ideal gas, Adiabatic changes: Work done in adiabatic process, Interrelation between thermodynamic parameters (P, V & T), slope of P-V curve in adiabatic & isothermal process. Application of first law of thermodynamics to chemical processes: exothermic, endothermic processes, law of Lavoisier & Laplace, Hess's law of constant heat summation, Kirchhoff's law.2nd law of thermodynamics: Statement, Mathematical form of 2nd law of thermodynamics (Carnot cycle).Joule Thomson &

throttling processes; Joule Thomson coefficient for Ideal gas, Concept of inversion temperature. Evaluation of entropy: characteristics & expression, entropy change in irreversible cyclic process, entropy change for irreversible isothermal expansion of an ideal gas, entropy change of a mixture of gases. Work function & free energy: Definition, characteristics, physical significance, mathematical expression of ΔA & ΔG for ideal gas, Maxwell's Expression (only the derivation of 4 different forms), Gibbs Helmholtz equation. Condition of spontaneity & equilibrium reaction. Chemical potential, Real gas, Real Solution, Cell EMF & its Thermodynamic derivation of the EMF of a Galvanic cell (Nernst equation), single electrode potentials, hydrogen half-cell, quinhydrone half-cell & 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) Ascertain the change in thermodynamic function (ΔG, ΔH, ΔS) b)ascertain the equilibrium constant of a reversible chemical reaction c) ascertain the valency of an ion. Corrosion - basics & impacts, Reaction laws: rate & order; molecularity; zero, first & second order kinetics. Pseudo unimolecular reaction, Arrhenius equation. Mechanism & theories of reaction rates (Transition state theory, Collison theory: Steady state approximation, Rate determining state approximations, Bohr's theory & its limitations, de-Broglie relation, Heisenberg Uncertainty principle, Schrodinger equation, Schrodinger equation for hydrogen atom in Cartesian coordinate & polar coordinates, Significance of four quantum numbers, shape of s, p & d atomic orbitals, discovery of spin, spin quantum number & magnetic quantum number. Rules for filling electrons in orbitals, stability of half & completely filled orbitals, relative energies of atomic orbitals, anomalous electronic configurations, The properties of liquid surface, surfactants, colloidal systems, solid surfaces, physio sorption, & chemisorption.

List of Experiments

1. Determination of water hardness by complexometric titration.
2. Determination of total alkalinity of water sample.
3. Determination of chloride ion in water sample by Argentometric method.

4. Determination of total dissolved oxygen content in water sample by Wrinkler's method.
5. Copper sulfate estimation by iodometric titration.
6. Potassium dichromate estimation by iodometric titration.
7. Redox titration: Estimation of FAS by internal & external indicators.
8. Gravimetric analysis: Estimation of Ba as $BaSO_4$
9. Gravimetric analysis: Estimation of Ag as AgCl
10. pH metric measurements: Determination of strength of unknown HCl solution by pH metric titration.

Text/Reference Books

1. Physical Chemistry. Atkins P. W. 5th Ed. ELBS. 1994.
2. Physical Chemistry. Levine I. A. 4th Ed. McGraw-Hill.1995.
3. Quantum Chemistry. Levine I. A. 2nd Ed. Prentice Hall. 1995.
4. Introductory Quantum Chemistry. Chandra A. K. 4th Ed. Tata McGraw-Hill. 1994

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Semester - I

(Humanities & Basic Sciences Subject)

MA-151 L-T-P-C
Mathematics - I 3-1-0-4

Objective: *To develop an understanding of the fundamental concepts of the calculus, differential equations & linear algebra to connect them with real world problems from other disciplines along with the development of mathematical reasoning & problem solving abilities.*

Course Content

Differential Calculus (Functions of one variable): Taylor's &Maclaurin's theorems with remainders, concavity & convexity of a curve, points of inflexion, asymptotes & curvature.

Differential Calculus (Functions of several variables): Partial derivatives & their geometrical interpretation, derivatives of composite & implicit functions, Euler's theorem on homogeneous functions, harmonic functions, Taylor's expansion of functions of several variables, maxima &minima - Lagrange's method of multipliers.

Integral Calculus**:** application to length, area, volume & surface area of revolution. Multiple integrals with applications to: volume, surface area & moments of inertia.

Ordinary Differential Equations**:** Solution of dy/dx = f(x, y); linear differential operator L, higher order ordinary differential equations with constant coefficients.

Matrix Algebra**:** Rank & inverse of a matrix, consistency of linear system of equations; Eigen values, Eigen vectors & their applications to system of ordinary differential equations; Cayley-Hamilton theorem; Diagonalization of matrices.

Text/Reference Books

1. Higher Engineering Mathematics. Ramana B.V. 1st Ed. Tata McGraw-Hill Education. 2006.
2. Calculus and Analytic Geometry. Thomas G. B. & Finney R. L. 9th Ed. Addison-Wesley. 1998.
3. Advanced Engineering Mathematics. Kreyszig E. 10th Ed. Wiley Eastern. 2012.
4. Advanced Engineering Mathematics. Jain R. K. & Iyengar S. R. K. 3rd Ed. Narosa Publishing House. 2010.
5. Calculus - Vol.2. Apostol T. M. 2nd Ed. Wiley .2003.
6. Higher Engineering Mathematics. Grewal B.S. 42nd Ed. Khanna Publishers. 2012.

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Semester - I

(Humanities & Basic Sciences Subject)

PH-151 L-T-P-C
Physics - I 3-0-1-4

Objective: *Objective of this course is to introduce concepts of electrostatics & magnetostatics leading to the Maxwell's electromagnetic waves & understanding the wave nature of light using various optical phenomena like interference, diffraction & polarization. The particle nature of electromagnetic wave will also be introduced*.

Course Content

Gauss law & its applications in electrostatics in vector form, electric polarization, permittivity, energy density in an electric field, Ampere's law, charged particle motion in E & B fields, magnetization, Faraday's law of electromagnetic induction; Equation of continuity, generalized Ampere's law, Maxwell's equations, wave equation, plane wave solutions, electromagnetic wave propagation in dielectrics & conductors, reflection/refraction, polarization, interference, diffraction of EM waves Origin of quantum hypothesis, de Broglie's hypothesis of matter waves, Uncertainty principle, Wave function & wave mechanics, Schrodinger equation, QM operators, Expectation value, one-dimensional solutions: zero potential, step potential, potential barrier & potential well.

List of Experiments

1. Determination of wavelength of sodium light source using Newton's Ring Method
2. Determination of wavelength of monochromatic light source using Fresnel's Biprism

3. Determination of the wavelength of monochromatic light using Michelson Interferometer
4. Determination of wavelength of laser using single slit diffraction
5. Determination of the wavelength of prominent lines of mercury using plane transmission grating
6. Determination of specific rotation of sugar solution using Polarimeter
7. Determination of Refractive index & dispersive power of prism material using spectrometer
8. Verification of the BiotSavart's law
9. Variation of magnetic field along the axis of a circular coil & determination of the radius of the coil
10. Determination of frequency of AC mains using Sonometer
11. Determination of the characteristic constant or ballistic constant of a ballistic galvanometer

Text/Reference Books

1. Elements of Electromagnetics. Sadiku M. N. O. 6th Ed. Oxford. 2014.
2. Optics. Ghatak A. Tata McGraw-Hill Publishing Company Ltd. 2005.
3. Electromagnetics. Laud B.B. 2nd Ed. New Age International (P) Ltd. 1987.
4. Classical Electrodynamics. Jackson J.D.3rd Ed. Wiley. 1998.
5. Foundations of Electromagnetic Theory. Reitz J.R., Milford F.J. & Christy R. W. 4th Ed. Narosa Pub. House. 2008.
6. Fundamentals of Optics. Jenkins F. A. & White H. E. 4th Ed. McGraw-Hill International Editions. 2001.

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Semester - II

(Departmental Core Subject)

CS-152 L-T-P-C
Introduction to Computers & Programming 2-0-2-4

Objective: *This course is an introductory course of computer science. It provides basic insight into the building blocks of a modern day computer & the newest peripherals attached with it. In addition to this, the learner is delved into the basic programming concepts of a high level language.*

Course Content

Introduction to computer architecture; memory, ALU, CPU, I/O devices. Introduction to system software; operating systems, compilers & multi-user environments. Concept of an algorithm. Introduction to the design & implementation of correct, efficient & maintainable programs. Use of high level programming language for the systematic development of programs.

List of Experiments

1. Basic & calculation based programs
2. Conversion based programs
3. Decision making statement & operator based programs
4. Loop based programs
5. Multi way decision making statement based programs
6. Array based programs
7. Strings based programs
8. Function based programs
9. Structure based programs

10. Pointers based programs
11. File handling based programs

Text/Reference Books

1. A Book on C. Kelly A. & Pohl I. 4th Ed. Pearson Education. 1999.
2. The C Programming Language. Kernighan B. & Ritchie D. 2nd Ed. Prentice Hall of India. 1988.
3. C: The Complete Reference. Schildt H. 4th Ed. Tata McGraw-Hill. 2000.

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Semester - II

(Departmental Core Subject)

EC-152 L-T-P-C
Basics of Electrical & Electronics Engineering 3-0-1-4

Objective: *The aim of this course is to develop an understanding of the basics of electrical & electronics components, circuits & systems, operation of transformers & other electrical machines.*

Course Content

Circuit Analysis Techniques: Circuit elements, Simple RL & RC Circuits, Ohm's law, Kirchoff's laws, Nodal Analysis, Mesh Analysis, Linearity & Superposition, Source Transformations, Thevnin's & Norton's Theorems, Phasor Relationship for R, L & C, Impedance & Admittance, Phasor Diagrams, Response as a function of ω.

Diodes & Transistors: Semiconductor Diode, Zener Diodes, Rectifier Circuits, Wave Shaping Circuits, Bipolar Junction Transistors, Field-Effect Transistors.

Operational Amplifiers: Op-amp Equivalent Circuit, Practical Op-amp Circuits, DC Offset, Constant Gain Multiplier, Voltage Summing, Voltage Buffer.

Logic Gates: Number Systems & Codes, Logic Gates, Boolean Theorems, De Morgan's Theorems, Sum-of Product Form, Algebraic Simplification, Karnaugh Map Method.

Introduction to Transformers & AC Machines: Ideal Transformer, Circuit Model of Transformer, Efficiency, Three Phase Induction Motor.

Introduction to Fractional-kW Motors & DC Machines: Single Phase Induction Motors, DC Generator & DC Motor.

List of Experiments

1. Study & Verification of Kirchoff's Current Law

2. Study & Verification of Kirchoff's Voltage Law
3. Study & Verification of Thevenin's Theorem for dc network
4. Study & Verification of Norton's Theorem for dc network
5. Study & Verification of R-C series circuit & determination of phase angle
6. Study of the volt-ampere (V-I) characteristics for Silicon P-N Junction diode
7. Study of the volt-ampere (V-I) characteristics for a Zener diode
8. Study of the input & output characteristics for a transistor in common base configuration
9. Verification of Truth Table for basic & universal logic gates
10. Determination of copper loss & core loss for a single phase transformer through O/C-S/C Test

Text/Reference Books

1. Engineering Circuit Analysis. Hayt W. H. & Kemmerly J. E. McGraw-Hill. 1993.
2. Circuits, Devices and Systems. Smith R. J. & Dorf R. C., John Wiley & Sons.1992.
3. Electronic Devices and Circuit Theory. Boylestad R. L. & Nashelsky L. 6th Ed. Prentice Hall India. 2001.
4. Digital Systems. Tocci R. J. 6th Ed. Prentice Hall India. 2001.
5. Electrical Engineering Fundamentals. Del T. V. Prentice Hall India. 1994.
6. Circuit Theory (Analysis and Synthesis). Chakrabarti A. Dhanpat Rai & Co. 2001.

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Semester - II

(Humanities & Basic Sciences Subject)

HU-154	L-T-P-C
Professional Communication - II	1-1-0-2

Objective: *To build interpersonal skills & communicate effectively.*

Course Content

Business Meetings: Notice, Agenda, Minutes of Meeting.

Group Discussions: Classification of GD topics; GD as a part of the selection process; GD phases; Non-verbal communication in GD, Do's & don'ts of GD.

Professional Mannnerisms & Grooming: Kinesics, Office etiquette; Telephone skills, Netiquette.

SWOT, Résumé, Cover letter writing, Job Acceptance Letter.

Goal setting: Significance, Progressive steps to achieve goals; Anticipating career challenges & utilizing opportunities.

Text/Reference Books

1. Foundations of Business Communication: An Integrative Approach. Young, D. McGraw Hill Education. 2005.
2. How to Succeed in Group Discussions and Personal Interviews. Mandal S. Jaico Publishers. 2004.
3. Business Communication: Connecting in a Digital World (SIE). Lesikar R. & Pande N. McGraw Hill Education. 2015.

Detailed Syllabus for B. Tech. Degree Programme in Chemical Engineering

Semester - II

(Humanities & Basic Sciences Subject)

CH-155 L-T-P-C
Chemistry - II 3-0-1-4

Objective: *This course aims at understanding various concepts of inorganic & organic chemistry, broad spectrum knowledge of chemical bonding, organic reaction mechanism, stereochemistry, spectroscopy, polymer science, green chemistry & environmental pollution studies.*

Course Content

Bonding Models in Inorganic Chemistry- Introduction, Ionic bonding: Introduction to stoichiometric defects (Schottky & Frenkel) & non – stoichiometric defects (Metal excess & metal deficiency).Role of silicon & germanium in the field of semiconductor. Valence shell Electron Repulsion Theory (VSEPR). Discussion of structures of IF_3, $SnCl_2$, CO_3^{2-} & Valence bond theory, Molecular orbital theory Linear combination of atomic orbitals (LCAO) method. Structures of simple hetero nuclear diatomic molecules such as CO, NO, HF, Coordination numbers, Crystal field theory, Metal ions in Biological systems, Air Pollution Types of pollutants, source effects, sink & control of primary pollutants – CO, NOx, HC, SOx& particulates, effects of pollutants on man & environment – photochemical smog & acid rain. Greenhouse effect, ozone layer depletion, Water Pollution: Classification of pollutants, their sources, effects of water pollutions on human & plant life, waste water treatment – domestic & industrial. Pollution due to Oil & grease in water. Thermal pollution: Sources, effects of thermal pollution on plant & animal life, control techniques, radioactive pollution: sources, effects, treatment& disposal,Solid Waste Management, Weapons of mass destruction, biological weapons, chemical weapons, disarmament & peaceful uses of chemistry in

day to day life. Green Chemistry, 12 principles of green chemistry, application of green chemistry in industrial processes, Renewable & Non-renewable energy resources & Primary & Secondary energy resources, Polymers, Organic Reaction Mechanism, Stereochemistry of Carbon Compounds, Basic concepts of spectroscopy, UV-VIS spectroscopy, applications, Fundamentals of Microwave & IR spectroscopy & its applications, determination of molecular structure.

List of Experiments

1. Inorganic qualitative analysis: Detection of acid radicals.
2. Inorganic qualitative analysis: Detection of basic radicals.
3. Estimation of available chlorine in bleaching powder sample.
4. Thin layer chromatography: Separation of given amino acids by TLC method.
5. Determination of rate constant of a first order reaction by titrimetric method.
6. Spectrophotometry: Verification of Beer's law.
7. Conductometric measurements: Determination of strength of unknown HCl solution by conductometric titration.
8. Qualitative analysis of single solid organic compounds: Detection of characteristic elements (N, Cl, Br & I) by chemical tests.
9. Qualitative analysis of single solid organic compounds: Detection of functional groups by systematic chemical tests.
10. Flame photometry: Determination of Na & K in water sample.

Text/Reference Books

1. Environmental Sciences towards sustainable future. Wright R. Prentice Hall of India. 2007.
2. Essentials of Ecology & Environmental sciences. Rana S. V. S. 3rd Ed. Prentice Hall of India. 2007.
3. Ecology. Subrahmanyam S. & Sambamurty S. S. 2nd Ed. Narosa Publishing House. 2007.
4. Concepts of Ecology. Kormondy E. J. 4th Ed. Prentice Hall of India Pvt. Ltd. 2007.
5. Textbook of Environmental Studies for Undergraduate Courses. Bharucha E. 2nd Ed. University Grants Commission. New Delhi. 2004.
6. Advanced Inorganic Chemistry. Cotton F. A. & Wilkinson G. 3rd Ed. Wiley Eastern Ltd.1972.
7. Inorganic Chemistry. Shriver D. J. Atkins P. W. & Langford C. H. 2nd Ed. ELBS.

1994.
8. Organic Chemistry. Pine S. H. 5th Ed. McGraw-Hill. 1987.
9. Fundamentals of Molecular Spectroscopy. Banwell C. N. & McCash E. M.4th Ed. McGraw-Hill. 1962.
10. Introduction to Molecular Spectroscopy. Barrow G. M. 5th Ed. McGraw-Hill 1962.
11. Green Chemistry Engineering. Doble M. & Kruthiventi A. K. Academic press.2007.

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Semester - II

(Humanities & Basic Sciences Subject)

MA-152 L-T-P-C
Mathematics - II 3-1-0-4

Objective: *The objective of the course is to make the students familiar with certain important mathematical techniques involving complex analysis & transforms which have applications in various disciplines of Engineering & Technology.*

Course Content

Complex Analysis**:** Complex Variables: Limit, continuity, differentiability & analyticity of functions, Cauchy-Riemann equations, line integrals in complex plane, Cauchy's integral theorem, independence of path, existence of indefinite integral, Cauchy's integral formula, derivatives of analytic functions, Taylor's series, Laurent's series, Zeros & singularities, Residue theorem, evaluation of real integrals.

Transform Calculus: Definition of Laplace Transform, linearity property, conditions for existence of Laplace Transform. First & second shifting properties, Laplace Transform of derivatives & integrals, unit step functions, Dirac delta-function, error function. Differentiation & integration of transforms, convolution theorem, inversion, periodic functions. Evaluation of integrals by Laplace Transform. Solution of initial & boundary value problems. Fourier Transform, Fourier sine & cosine transforms. Linearity, scaling, frequency shifting & time shifting properties. Self reciprocity of Fourier Transform, convolution theorem. Applications to boundary value problems. Brief Introduction of Z-Transform, Mellin transform & Wavelet Transform.

Fourier Series :Periodic functions, Fourier series representation of a function, half range series, sine & cosine series, Fourier integral formula, Parseval's identity.

Text/Reference Books

1. Higher Engineering Mathematics. Ramana B. V. 1st Ed. Tata McGraw-Hill Education. 2006.
2. Complex Analysis for Mathematics and Engineering .Mathews J. H. & Howell R. W. 3rd Ed. Narosa. 1998.
3. Advanced Engineering Mathematics .Kreyszig E. 10th Ed. Wiley Eastern. 2012.
4. Advanced Engineering Mathematics. Jain R. K. & Iyengar S. R. K. 3rd Ed. Narosa Publishing House.2009.
5. Complex Variables- Introduction and Applications. Ablowitz M. J. & Fokas, A. S. Cambridge University Press. 1998.
6. Complex Variables and Applications .Brown J. W. & Churchill R. V. 7th Ed. Mc-Graw Hill. 2004.

Detailed Syllabus for B. Tech. Degree Programme in Chemical Engineering

Semester - II

(Humanities & Basic Sciences Subject)

PH-152 L-T-P-C
Physics - II 3-0-1-4

Objective: *The objective of this course to introduce the notion of quantum physics & its applications in understanding the electrical, thermal & magnetic properties of various materials, band theory of solids, nanostructures, lasers, superconductivity & its applications.*

Course Content

Nature of waves & particles, Wave-packets & uncertainty, Wave particle duality, Wave mechanics & its mathematical tools, Classical & quantum statistics, Statistics of discrete energy levels, Black body spectral density, Bose condensation; Free electrons, density of states, Kronig-Penny model, Effective mass, Band structure, Electrons in various types of solids, Particle in quantum well, Harmonic oscillator & Hydrogen atom problems, Application to semiconductor doping, Nonperiodic materials; Tunneling of particles & examples, Tunneling through multiple barriers & semiconductor junctions; Interaction among quantum wells: materials under electric & magnetic fields, magnetic resonance effects; Nanostructures – Concepts of electrons in low dimensional confinement, Quantum wells & Super-lattices leading to new device concepts; Lasers – Einstein coefficients, Population inversion, Light amplification, Optical resonators, Characteristics of lasers; Superconductors –Vortex, Flux quantization, SQUID, Levitation & its applications.

List of Experiments

1. Determination of Planck's constant using Light Emitting Diode

2. Determination of temperature coefficient, reverse saturation current & energy band gap of a P-N junction
3. Determination of the energy band gap of semiconductor using four-probe method
4. Determination of the charge carrier concentration & Hall coefficient of a given semiconductor using Hall experiment setup
5. Determination of the ratio of e/m for the electron using the helical method
6. Determination of electronic charge by Millikan's oil drop method
7. Determination of velocity of ultrasonic waves using quartz crystal
8. Determination of wavelength of He-Ne laser using millimeter scale as a grating
9. Determination of wavelength of Diode laser using single slit / double slit & obtain diffraction patterns of different apertures
10. Determination of numerical aperture of an optical fibre cable
11. Determination of capacitance of a parallel plate capacitor with & without dielectric material
12. Determination of the height of a distant object/building with the help of sextant

Text/Reference Books

1. Concepts of Modern Physics. Beiser A. 5th Ed. McGraw-Hill.1995.
2. Modern Physics. Krane K. S. 2nd Ed., John-Wiley. 1995.
3. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles. Eisberg R. & Resnick R. 2nd Ed. John-Wiley. 1985.
4. Introduction to Solid State Physics. Kittel C. 7th Ed. John-Wiley India Pvt. Ltd. 1995.
5. Solid State Physics. Pillai S. O. 6th Ed. New Age International Publishers Ltd. 2009.
6. Semiconductor physics and devices. Neamen D. 4th Ed. McGraw-Hill. 2011.

EP-199/EP-299/EP-399/EP-499 L-T-P-C
Endeavour Project (Beyond the Syllabus) 0-0-0-3

Our University is continuously looking at innovative ways to deliver knowledge to our students, making learning & delivery mechanism innovative, interesting & easy with truly 'out of the box' teaching-learning process. This beyond the syllabus initiative uses all working second Saturdays as class days.

Endeavour is a compulsory interdisciplinary project for all students of the University. Respective Heads of the Department shall select students & form groups. Each project shall be supervised by a faculty member.

The faculty of SPSU will select a contemporary topic, which is preferably industry relevant & associate a company or professional who can provide application-oriented perspective. The topic chosen may be from wide range of subjects. For example: - Biodiversity, Social subjects, Media & advertisement, Environment, Scientific, Technical, Management, Architecture, Tourism or any other subject or their combination.

The project is evaluated in two phases: Internal Evaluation & External Evaluation. This ensures descriptive assessment of the projects performance & challenges faced during the implementation of the project. The project will be spread over two semesters beginning from the odd semester (July to November) & ending in the even semester (December to May) every year. The grade obtained in this course may be used to improve the student's semester grade point average.

The final report should include the reasons for the choice of the title, the concept, the structure, the results with working models/drawings etc. & its practicality. The role & responsibility of every individual of the group should be indicated clearly. The report should be written in the prescribed format/guidelines, certified by the faculty member & presented as a seminar.

The project is evaluated as per the approved procedure & marks obtained are computed in the even semester.

Detailed Syllabus for B. Tech. Degree Programme in Chemical Engineering

Semester - III

(Departmental Core Subject)

CM-251 L-T-P-C
Introduction to Chemical Engineering 3-1-0-4

Objective: *To understand history and scope of chemical engineering, unit operation and processes, industrial safety management, operation and maintenance of chemical plant.*

Course Content

Historical overview of Chemical Engineering: Concepts of unit operations & unit processes, & more recent developments, Features of organized chemical processing-from chemistry to chemical engineering. The Chemical Industry-scope, features, characteristics & scope. Principles of balancing with examples to illustrate differential & integral balances lumped & distributed balances. Material balances in simple systems involving physical changes & chemical reactions; systems involving recycle, purge. & bypass. Properties of substances: single component & multicomponent, single & multiphase systems. Use of Compressibility charts, vapour pressure correlations/charts & Psychometric charts. Ideal liquid and gaseous mixtures. Energy balance calculations in simple systems. Introduction to Computer aided calculations-steady state material and energy balances.

Text/Reference Books

1. Elementary Principles of Chemical Processes, R. M. Felder & R.W. Rousseau, 3rd ed., John Wiley, New York, 2004.
2. Basic Principles and Calculations in Chemical Engineering, D. M. Himmelblau & J. B. Riggs, 7th ed., Prentice Hall, 2003.
3. Stoichiometry, B. I. Bhatt & S. M. Vora, 4th ed., McGraw Hill, 2004

Detailed Syllabus for B. Tech. Degree Programme
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Semester - III

(Departmental Core Subject)

CM-252 L-T-P-C
Material Science 3-1-0-4

Objective: *This course will enable students to understanding of mechanics, physical and chemical properties of materials including metals, ceramics, polymers, and composites.*

Course Content

Introduction on materials for engineering, structures of metals, ceramics and polymers; crystalline structure imperfections; amorphous and semi-crystalline materials (includes glasses, introduction to polymers); Correlation of structure to properties and engineering functions (mechanical, chemical, electrical, magnetic and optical); phase diagrams; Improving properties by controlled solidification, diffusion or heat treatment; Failure analysis and non-destructive testing; Types of materials (includes synthesis, Fabrication and processing of materials): Polymers and composites, Environmental degradation of materials (corrosion); Evolution of materials (functional materials, Biomimetic materials, energy saving materials etc.); Criteria for material selection.

Text/Reference Book

1. Materials Science and Engineering: An Introduction, William D. Callister Jr., David G. Rethwisch, 9th Edition, 2013.

Detailed Syllabus for B. Tech. Degree Programme in Chemical Engineering

Semester - III

(Departmental Core Subject)

CM-253 L-T-P-C
Chemical Process Calculations 3-1-0-4

Objective: *This course will enable students to learn basic laws about the behavior of gases, liquids and solids and some basic mathematical tools. Understand systematic problem solving skills, enhance confidence, and generate careful work habits.*

Course Content

Numerical techniques for solving material & energy balance equations. Material balance with and without chemical reactions, Recycle, bypass, purge calculations, computer based calculations. Vapor-liquid equilibrium: Bubble point, dew point calculations, phase envelop calculations. Introduction to Fuels (solid, liquid, and gas): Important properties and specifications. Energy balances with and without chemical reactions; psychometric calculations; fuel calculations, adiabatic flame temperature; computer-based calculations for energy balance.

Text/Reference Books

1. Chemical Process Principles, Part I by O. A. Hougen, K. M. Watson & R. A. Ragatz, Second Edition. John Wiley & Sons, Inc., New York (1954)
2. Basic Principles and Calculations in Chemical Engineering by D. M. Himmel – blau, 8th Edition, Prentice Hall 2012.

Detailed Syllabus for B. Tech. Degree Programme in Chemical Engineering

Semester - III

(Departmental Core Subject)

CE-254 L-T-P-C
Fluid Mechanics 3-0-1-4

Objective: *The aim of this course is to introduce & explain fundamentals of Fluid Mechanics, which is used in the applications of Aerodynamics, Hydraulics, Civil Engineering, Gas dynamics etc. This course will also help to learn fluid properties & hydrostatic law & to understand the importance of flow measurement & its applications in industries.*

Course Content

Fluid properties; Pressure measurement; Hydrostatic forces on plane & curved surfaces; Buoyancy & equilibrium; Stability, metacentric height; Types of flow; Continuity; Energy & momentum equations; Velocity distribution & velocity coefficients, practical applications; Navier Stoke equation; Shear stress & pressure gradient; Flow through pipes, Hagen-Poiseuille equation; Turbulence, Prandtl's mixing length, eddy viscosity; Darcy-Weisbach equation for flow through pipes, friction factor, Moody diagram, minor losses, pipes in series & parallel, equivalent length, pipe network analysis; Water hammer; Boundary layer concept, drag coefficients, control of boundary layer; Dimensional analysis & similitude.

List of Experiments

1. Measurement of fluid pressure using various manometers & gauges
2. Experimental study on capillarity
3. Determination of coefficient of viscosity of a fluid using viscometer

4. Experimental study on stability of floating bodies
5. Experiments on fluid pressure distribution on immersed bodies
6. Different types of flow using Reynold's apparatus
7. Determination of friction factor in pipes using pipe friction apparatus
8. Experiments on flow nets using Hele-Shaw apparatus
9. Experiments on cavitations
10. Flow behavior in open channels using tilting flume

Text/Reference Books

1. Hydraulics & Fluid Mechanics. Modi P.N. & Seth S.M. Standard Book House. 1998.
2. Fluid Mechanics. Streeter V.L. & Wylie E.B. McGraw Hill. 1997.
3. Fluid Mechanics. B.F. White. McGraw Hill.1994.

Detailed Syllabus for B. Tech. Degree Programme in Chemical Engineering

Semester - III

(Humanities & Basic Sciences Subject)

HU-251 L-T-P-C
Business & Technical Communication 1-1-0-2

Objective: *To develop persuasive & professional communicative competence.*

Course Content

Presentation Skills: Types of presentation; Effective strategies for oral presentations - audience analysis; organizing contents & use of media; Awareness of body language, time & space; Tone, variety of pitch, rate, volume & Articulation.

Letter Writing: Essentials of an effective business letter, Types of business letters: Sales Letter, Complaint Letter, Claim & Adjustment Letters.

Technical Report Writing: Characteristics & structure of a formal report; Classification & types of reports; Organization, Analysis & Interpretation of data; Revising & Editing especially in areas like abstracting/ summarizing as well as citations, references & bibliographies, check list for reports.

Text/Reference Books

1. How to Prepare, Stage and Deliver Winning Presentations. Leech T. 2nd Ed. Prentice Hall. 2004.
2. Business Communication Today. Boove C & Thill J. 11th Ed. Prentice Hall. 2011.
3. Effective Technical Communication. Rizvi A. 11th Ed. Tata McGraw-Hill Publishing Company Ltd. 2005.

Detailed Syllabus for B. Tech. Degree Programme in Chemical Engineering

Semester - III

(Humanities & Basic Sciences Subject)

MA-251 L-T-P-C
Introduction to Algebra & Matrix Analysis 3-1-0-4

Objective: *This course will help the students to build a strong foundation in mathematics & develop abstract thinking skills.*

Course Content

Group theory: Product of sets; mappings & their compositions; Groups, subgroups, Normal subgroups, Factor subgroups ,Lagrange's theorem, Homomorphism & Isomorphism theorems, Permutation groups, Matrix groups, Abelian groups. Rings & Fields, Ideals, Homomorphism, Euclidean domains, Finite & Infinite fields, Polynomial rings Matrix rings.

Linear Algebra & Matrix Theory: Vector spaces, subspaces, direct sums, bases & dimension, Linear transformation, Matrix of the linear transformation, Change of basis, rank-nullity theorem. Eigen values & Eigen vectors, The Characteristic & Minimal polynomials, Diagonalization. Finite dimensional inner product spaces, Graham Schmidt orthogonolization process, Linear functional, Adjoints of linear operators. Self-adjoint & normal linear operators. Normal linear spaces, Examples of Banach & Hilbert spaces.

Text/Reference Books

1. Elementary linear algebra with applications. Anton H. 8th Ed. John Wiley. 1995.
2. Matrix and Linear Algebra. Dutta K. B. 7th Ed. PHI. 2006.
3. A first course in abstract algebra. Farleigh J. B. 7th Ed. Pearson Education. 2002.
4. Linear Algebra. Hoffmann K. & Kunze R. PHI. 1971.
5. Applied Linear Algebra. Olver P. J. & Shakivban C. 1st Ed. PHI. 2005
6. Linear algebra - A Geometric approach. Kumaresan S. 1st Ed. PHI. 2000.

Detailed Syllabus for B. Tech. Degree Programme in Chemical Engineering

Semester - IV

(Departmental Core Subject)

CM-254 L-T-P-C
Heat Transfer 3-1-0-4

Objective: *To understand various modes of Heat Transfer employed in the industries and various equipment's used to carry out the operation of heat transfer*

Course Content

Mechanisms of heat flow - conduction, convection, and radiation. Conduction Steady and unsteady state one, two and three dimensional conduction equations in different geometries. Convection-Dimensional analysis, forced and natural convection. Radiation-Stefan Boltzman law, Kirchoff s Law, and their applications, black body, grey body, exchange of radiant heat between grey bodies. Furnaces, flame temperature, optimum thickness of insulation. Heat exchangers- Classification and design, metallic and non-metallic heat exchangers. Evaporators-Types and design features. Design of natural and forced circulation reboilers- optimization of heat exchanger design; heat exchanger performance evaluation. Process design and performance evaluation of Double Pipe, Shell and Tube, Plate, Spiral Heat Exchangers; Process design data sheets. Heat pumps.

Text/Reference Book

1. Heat transfer. J. P. Holman. 7th Edition, Publisher, McGraw-Hill, 1989

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Semester - IV

(Departmental Core Subject)

CM-255 L-T-P-C
Chemical Engineering Thermodynamics 3-1-0-4

Objective: *In this course, students learn how to apply knowledge of the laws of thermodynamics, chemistry, physics, and engineering to analyze and solve physical and chemical problems encountered in chemical and biochemical engineering.*

Course Content

Estimation of properties: Real fluids and their mixtures, computer-aided algorithms for property estimation and their applications to chemical engineering processes. Heat effects of industrial reactions: Theory and applications. Multiphase processes and multi component equilibria; Chemical reaction equilibria; Thermodynamic analysis of real processes.

Text/Reference Books

1. Introduction to Chemical Engineering Thermodynamics, J. M. Smith, H. C. Van Ness, M. M. Abbott, 7th Edition McGraw Hill Education.
2. Fundamentals of Classical Thermodynamics, Van Wylen, G. J. & Sonntag, R. E., 2nd ed., John Wiley, New Delhi.

Detailed Syllabus for B. Tech. Degree Programme in Chemical Engineering

Semester - IV

(Departmental Core Subject)

CM-256 L-T-P-C
Chemical Reaction Engineering 3-1-1-5

Objective: *To understand the effect of non-ideal flow on reactor erformance and to design reactors for heterogeneous reaction systems*

Course Content

Rate laws and stoichiometry. Isothermal reactor design- Batch, plug flow and mixed flow. Heterogeneous reactions and effects of mass and heat transfer. Chemical reactor analysis: Non-ideal reactors, non-isothermal reactors, and design. Catalyst preparation and characterization. Deactivation of catalyst. Multiphase reactions: Gas-liquid, liquid-liquid, gas-solid, solid liquid-gas.

List of Experiments

1. Determination of the order of a reaction using a batch reactor and analyzing the data by (a) Differential method (b) integral method.
2. Determination of the order of a reaction and rate constant using a packed bed reactor and analyzing the data by (a) differential method (b) integral method
3. Determination of the activation energy of a reaction using a batch reactor
4. To determine the effect of residence time on conversion and to determine the rate constant using a CSTR.
5. To determine the specific reaction rate constant of a reaction of a known order using a batch reactor.

Text/Reference Books

1. Elements of Chemical Reaction Engineering, Fogler H.S, Prentice Hall, 1986.
2. Chemical Reaction Engineering, Octavelevenspiel, 3 rd Edition ,John wiley and sons

Detailed Syllabus for B. Tech. Degree Programme in Chemical Engineering

Semester - IV

(Department Core subject)

ME-261 L-T-P-C
Fluid Mechanics – II 3-1-0-4

Objective: *This course discusses some of the advanced concepts of fluid mechanics. This course requires basic knowledge of fluid mechanics. This course will enable us to understand various applications of fluid mechanics*

Course Content

Viscous Flow & Boundary Layer Theory: Introduction to Navier-Stokes Equations; Boundary-layer equations; Momentum integral estimates; Laminar flat plate boundary layer – Blasius equation; Displacement & momentum thickness; Boundary layers with pressure gradient; Flow separation; Turbulent flat plate boundary layers. Compressible Flow: The speed of sound; Adiabatic & isentropic steady flow - Mach-number relations, Isentropic flow with area changes; Normal-shock wave - Rankine-Hugoniot relations; Mach waves, oblique shock wave, Prandtl Meyer expansion waves; Performance of nozzles; Fanno & Rayleigh flow. Turbomachines: Euler-equation for turbomachines; Impulse turbine- Pelton wheel; Reaction turbine- Francis turbine, propeller turbine; Centrifugal pump; Performance parameters & characteristics of pumps & turbines; Cavitation; Net positive suction head (NPSH); Role of dimensional analysis & similitude; Positive displacement pumps.

Text/Reference Books

1. Fluid Mechanics. White F. M. 6th Ed. Tata McGraw-Hill. 2008.
2. Introduction to Fluid Mechanics. Fox R. W., McDonald A. T. & Pritchard P. J. 6th Ed. John Wiley. 2004.

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Semester - IV

(Department Core subject)

BT-269 L-T-P-C
Environmental Biotechnology 3-0-0-3

Objective: *This course is designed to provide basic knowledge of industrial waste treatment methods involving the application of microorganisms & bio-fuels*

Course Content

Biological Treatment of Wastewater – Aerobic System: Activated Sludge Process, Trickling Filters, Biological Filters, Rotating Biological Contractors (RBC), Fluidized Bed Reactor (FBR), Expanded Bed Reactor, Inverse Fluidized Bed Biofilm Reactor (IFBBR) Packed Bed Reactors Air- Sparged Reactors; Anaerobic Biological Treatment - Contact Digesters, Packed Column Reactors, UASB. Bio-remediation: Constraints & Priorities of Bioremediation, Bio stimulation of Naturally Occurring Microbial Activities, Bio augmentation, In Situ, Ex Situ, Intrinsic & Engineered Bioremediation, Solid Phase Bioremediation - Land Farming, Prepared Beds, Soil Piles, Phytoremediation. Composting, Bioventing & Bio sparging; Liquid Phase Bioremediation - Suspended Bioreactors, Fixed Biofilm Reactors. Bio Fuels: Microorganisms & Energy Requirements of Mankind; Production of Nonconventional Fuels - Methane (Biogas), Hydrogen, Alcohols & Algal Hydrocarbons, Use Of Microorganisms in Augmentation of Petroleum Recovery. Hazardous Waste Management: Xenobiotic Compounds, Recalcitrance, Biodegradation of Xenobiotics. Biological Detoxification.

Text/Reference Books

1. Environmental Biotechnology. Agarwal S.K. Alp Books.
2. Biodegradation and Bioremediation. Alexander M. Academic Press.1999

3. General Microbiology. Stanier R. Y., Ingram J.L. , Wheelis M. L. & Painter R. R. Mcmillan Publications. 1989.
4. Environmental Biotechnology.Foster C.F.Ware,John D. A. Ellis Horwood Ltd.1987.

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Semester - V

(Departmental Core Subject)

CM-351 L-T-P-C
Mechanical Operation 3-1-0-4

Objective: *The main goal of the course is introduction to theory and practice of mechanical operation as unavoidable part of process engineering to students of master studies in module process engineering. Considering the role of mechanical engineers in process engineering special focus will be set on construction of machines for mechanical operations.*

Course Content

Principles of crushing and grinding, Laws of crushing and grinding. Determinations of mean particle size, Size distribution equations. Characteristics of industrial crushers and mills. Industrial screening, effectiveness of screens, cyclones. Fluid-particle mechanics, free and hindered settling. Industrial classifiers, clarifiers and thickeners, gravity separation, tabling and jigging. Floatation and its kinetics, magnetic and electrostatic separation and precipitation. Mixing of liquids and solids, power requirement in mixing. Principles of filtration, filtration equipment's. Introduction to storage and conveying, elevating equipment's, hydraulic and pneumatic transport.

Text/Reference Book

1. Unit Operations of Chemical Engineering ,McCabe, W.L., Smith, J.C., and Harriott, P., 6th ed., McGraw Hill.

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Semester - V

(Departmental Core Subject)

CM-352 L-T-P-C
Fundamentals of Bioenergy 3-1-0-4

Objective: *To understand the techniques of estimating the biomass energy and to analyze its conversion methodologies for power generation.*

Course Content

Earths energy budget and momentum transfer; Climate systems, Green House Gases, Energy challenge for emerging nations; Food vs. Fuel debate; Land use and Remote Sensing analysis; Bioenergy crops: second generation crops, new opportunities and synergies based on land analysis; Life Cycle Analysis. Biomass resources: Starch, Sugar, Lignocellulose, Oilseeds, Municipal Solid Wastes; Cellular Bioenergetic Pathways; Enzyme Kinetics, Immobilized Enzymes; Microbial and Fungal Growth; Design, Analysis and Stability of Bioreactors; Production of Cellulosic Fuels: effects of mass transport on reaction kinetics; Biodiesel production: kinetics and thermodynamics; Bio-hydrogen production: fermentation and photobiological methods; Bio-gas production: anaerobic digestion; Microbial Fuel Cells; By-product recovery and utilization.

Text/Reference Books

1. Biofuels Engineering Process Technology, C. M. Drapcho, N.P. Nhuan, T.H. Walker, McGraw Hill,
2. Biomass to Renewable Energy Processes, Ed. Jay Cheng, CRC Press, Taylor and Francis Group,

Detailed Syllabus for B. Tech. Degree Programme in Chemical Engineering

Semester - V

(Departmental Core Subject)

CM-353 L-T-P-C
Mass Transfer - I 3-1-0-4

Objective: *The objective is to bring in the concept of mass transfer, which is mass in transit as a result of species concentration difference in a mixture.*

Course Content

Fundamentals of mass transfer: Diffusional mass transfer, mass transfer coefficients, steady state and unsteady state theories of mass transfer, interphase mass transfer, Whitman s two film theory and its variations, multiphase contacting equipments, concept of transfer unit, unified approach to staged processes.Distillation: Vapour-liquid Equilibria â x-y, t-x-y, P-x-y and H-x-y diagrams; Henry s, Raoult s and Dalton s Laws; Ideal and Non-ideal solutions â Azeotropes; Relative Volatility; Flash Vaporization; Differential Distillation; Steam Distillation; Continuous Rectification â Staged Calculation using Ponchon-Savarit and McCabe-Thiele Methods; Complex/Multi-draw Configuration; Packed Distillation Column; Multicomponent Distillation; Azeotropic and Extractive Distillations; Performance Evaluation of Distillation Columns including Reboilers and Condensers.Absorption: solubility, choice of solvent, concept of rate approach and stagewise approach, stage-wise and continuous contact absorbers; rich and lean gases; absorption with chemical reaction. Counter-current and co current multistage operations, dilute and concentrated systems, process design and performance evaluation of absorbers.Crystallisation: Theory of solubility Crystallization, phase diagram (temp/solubility relationship), crystal geometry; crystal nucleation and growth; equilibria and yields; population balance analysis, method of moments for rate expressions for, volume, area and length growth, CSD distribution, MSMPR operation,

programmed evaporative and cooling (rate expressions), most dominant size, ideal classified bed, melt Crystallization, process design of crystallisers and their operation, selection and specification of crystallisers like OSLO, Swenson Walker, agitated type, etc. performance evaluation of crystallisers.

Text/Reference Book

1. Principle of Mass Transfer & Separation Process, B.k Dutta, PHI.

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Semester - V

(Departmental Core Subject)

CM-354 L-T-P-C
Instrumentation & Process Control 3-1-1-5

Objective: *To impart knowledge about the various techniques used for the measurement of primary industrial parameters like flow, level, temperature, pressure etc.*

Course Content

Instrumentation : Static and dynamic characteristic of instruments. Measurement of temperature, pressure, vacuum, fluid flow rate and level. Process Control : Modeling considerations for control purposes. State Space and Transfer function models. Dynamic behavior of first and higher order systems. Concept and dynamic behavior of feedback control. Frequency response analysis. Stability analysis of feedback systems. Design of feedback controllers. Feed forward, Ratio, Adaptive and inferential control. Control systems with multiple loops.

List of Experiments

1. Characteristics of RTD
2. Characteristics of Thermistor
3. Study of IC solid state Sensors
4. Measurement of displacement using LVDT
5. Measurement of Load using Load cell
6. Study of pressure sensors

7. Study of Thermopile
8. Measurement of conductivity of a solution
9. Study of PID controller
10. Mini project using Temperature sensors

Text/Reference Books

1. Instrumentation, Measurement and Analysis; Nakra, Tata McGraw Hill, New Delhi.
2. Principles of Industrial Instrumentation, Patranabis, D., 2nd ed. Tata McGraw Hill, New Delhi.

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Semester - V

(Departmental Core Subject)

BT-353 L-T-P-C
Bioprocess Engineering 2-1-2-5

Objective: *This course discusses the basic concepts of fermentation, sterilization, media design, biochemical energetic, microbial growth kinetics involved in fermentation processes & interdisciplinary applications of bioprocess development used in research & industries.*

Course Content

Microbial growth, substrate utilisation & product formation kinetics; simple structured models; air sterilization; media sterilization; batch, fed-batch & continuous processes; aeration & agitation; rheology of fermentation fluids; scale-up concepts; design of fermentation media; aseptic transfer; various types of microbial & enzyme reactors; instrumentation in bioreactors.

List of Experiments

1. Preparation of broth media & solid media for microbial growth
2. Study & estimation of microbial growth in a shake flask culture
3. Determination of Wet microbial biomass in a culture
4. Estimation of Monod Parameters for microbial growth kinetics
5. Temperature effect on growth-estimation of energy of Activation & Arrhenius Constant for microorganisms
6. Demostration of a Lab Scale Fermentor

Text/Reference Books

1. Biochemical Engineering Fundamentals. Bailey & Ollis. 2 nd Ed. McGraw Hill.1986.
2. Bioprocess Engineering, Shule & Kargi.Prentice Hall.1992.
3. Principles of Fermentation Technology. Stanbury, P. F., Whitaker A., & Hall, S. J. 2nd Ed. Elsevier Science Publishers.1998
4. Introduction to Biochemical Engineering.Rao D.G.Tata McGraw Hill . 2005.

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Semester - VI

(Departmental Core Subject)

CM-355 L-T-P-C
Chemical Process Technology 3-1-0-4

Objective: *To provide an understanding of processes of different chemical and process industries.*

Course Content

Scope of CPT in process industries, introduction of CPT with reference to Indian resources, industries, trade and export potentials, small scale industries and rural development etc.; preparation of process flow diagrams and process and instrumentation diagrams and major process symbols. Introduction to the following industries including the special features of design and operation : Fuel and industrial gases including natural gas; petrochemical and downstream industries (in brief); polymer industries; fertilizer industries; caustic chlorine industries, coal based chemical industries, petroleum refining processes (in brief) and allied industries including additives etc.; nitrogen and nitrogen derivatives industry; sulphur and sulphur derivatives industry, phosphorus and its derivatives industry; soap and detergent industry, pulp and paper industry, alcohols and allied chemicals industry; other important basic and specialty chemicals industry; process software

Text/Reference Book

1. Basic Principles and Calculations in Chemical Engineering, Himmelblau, D. M., 6th ed., Prentice-Hall of India. 2008.

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Semester - VI

(Departmental Core Subject)

CM-356 L-T-P-C
Mass Transfer - II 3-0-1-4

Objective: *To impart the knowledge of separation processes like distillation, adsorption, and extraction.*

Course Content

Mass and heat balances in bulk and at interfaces, Spray chamber, Cooling towers - counter-current, co-current and cross-current, Performance evaluation of cooling towers, Principles of air conditioning. Drying: Theory and mechanism of drying, Batch and continuous drying; Drying rate curves, Estimation of drying times, Cross-circulation and through-circulation drying, Transfer unit concept in drier, Design calculations with special reference to rotary and spray driers, Special driers â Fluidizedbed, Flash, Dielectric, Freeze, Infrared.Liquid-Liquid Extraction: Ternary liquid equilibria, Solvent selection, Cross-current and counter-current multistage extraction, Staged calculations, Mixer-settlers; Extraction with reflux, Extraction equipment, Performance evaluation of extractors.Leaching: Solid-liquid equilibria, Single and multistage, Cross-current and countercurrent leaching, Steady state and unsteady state operations, Operation and performance evaluation of leaching equipments.Adsorption and Ion Exchange: Adsorption equilibria - Various isotherms, Breakthrough curves, Basic equations, Ion exchange equilibria, Contact filtration, Design of adsorbers and ion exchangers, Chromatography.Membrane Separations: Reverse osmosis, Dialysis, Microfiltration, Ultrafiltration; Pervaporation, Separation of gases and liquids.

Text/Reference Books

1. Mass Transfer Operation, Treybal, R.E.; McGraw-Hill, 1980.
2. Unit Operations of Chemical Engineering, McCabe, W.L. Smith, J.C. & Harriot, P., 6th ed, McGraw-Hill, NY

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Semester - VI

(Departmental Core Subject)

CM-357 L-T-P-C
Computer Aided Process Engineering 3-1-0-4

Objective: *To familiarize students with computer aided design of Industrial processes / equipment and make them acquainted with development of CAD (software) packages*

Course Content

Importance of VLE/ LLE calculations for process simulation. Process modeling and simulation, Information Flow diagram, modelling of different process equipment – heat exchangers, furnaces, flash drum, distillation, absorption, other staged / differential contacting processes, reactors etc. Process flowsheeting and simulators - Simulator components and structures, Salient features of simulators like ASPEN etc. Industrial Automation-Real time systems and Process optimization, Concepts of process economics. Process Integration-Pinch Technology, Heat exchangers network design, MER design, Energy tradeoff for reducing number of units, Stream splitting, optimization of mass exchangers network and water system. Use of AI (Fuzzy logic, ANN, GA etc.) techniques in process diagnosis, control and optimsation.

Text/Reference Book

1. Design of Equilibrium stage Processes, Smith, B.D., McGraw-Hill, NY

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Semester - VI

(Departmental Core Subject)

CM-358	L-T-P-C
Fuel Technology	3-0-2-5

Objective: *The main aim of the course is to give an introduction to the different types of fossil fuels. The emphasis of the course will be on the characterizations and utilizations of solid fuels, basics of liquid and gaseous fuels.*

Course Content

Fossil energy resources and reserves. Production and consumption pattern in India. Alternative energy resources. Characterization of coal, biomass and other fossil fuels including petroleum and petroleum products. Classification and commercial trading of coal. Coal preparation. Simulation and modeling of coal preparation circuits. Theory of coal pyrolysis and carbonization. Gasification of coal including producer and water gas. Conversion processes for coal into synthetic liquid fuel. Basic principle of combustion. Adiabatic combustion temperature, ignition temperature, etc. Coal combustion in fixed and fluidized bed. Pulverized coal firing processes.

List of Experiments

1. Proximate Analysis of coal
2. Ultimate Analysis of coal
3. FSI Analysis of coal
4. Determination of Caking Index of coal
5. Determination of GCV of solid fuel

6. Determination of HGI of coal

7. Determination of LTGK of coal

Text/Reference Book

1. Fuels & Combustion, 3rd Edition, Samir Sarkar. Publisher, Orient Longman, 1974.

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Semester - VII

(Departmental Core Subject)

CM-450 L-T-P-C
Summer Internship 0-0-0-3

Summer Internships offer students personal & real world spirits & exposes to an actual working life, an experiential foundation to their career choices & the chance to build valuable business networks. Under this programme each student undergoes training in an Industry for a minimum period of six weeks during the summer vacation after VI Semester. Through the internship students are exposed with the various processes involved at any typical industrial unit such as, operating procedure, construction processes, management procedures etc. & have the opportunity to relate with the knowledge they acquired in the classroom. Students execute a small project based on any of the above mentioned aspects under the supervision of competent personnel in the industry & a faculty member of the university.

After completion of the Internship, students are required to prepare a report, based on the activities performed during the internship, as per the prescribed format/ guidelines. The report should be certified by the Supervisors, & presented in the form of a seminar in the VII Semester.

Evaluation of the Summer Internship will be done as per the approved procedure.

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Semester - VII

(Departmental Core Subject)

CM-455	L-T-P-C
Comprehensive Viva Voce	0-0-0-2

The knowledge gained by the students during their B.Tech. programme will be evaluated through a Comprehensive Viva Voce Test in the VII Semester. The test will cover the entire syllabi of the B.Tech. degree programme. Preparation for the Comprehensive Viva Voce Test will also help the students in their placement activities. The evaluation will be done as per the approved procedure.

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Semester - VII

(Departmental Core Subject)

CM-460 L-T-P-C
Minor Project 0-0-3-3

Students undertake project work to develop the skill & aptitude of problem-solving. The project work is divided into two parts: Minor & Major. The Minor project is to be undertaken in the VII Semester.

Students will choose an area of their interest in consultation with a faculty member of the department, who will act as the Supervisor. The area of interest could be confined to his/her discipline or may be interdisciplinary.

The project work will involve all or some of the following processes: identification of problem, study of related literature, data collection & analysis, theoretical formulation, fabrication, experimentation & result analysis.

The preliminary work such as problem identification through literature survey, field survey etc. & preparation of plan of execution should be complied in the form of a report, in the prescribed format/ guidelines. The report, duly certified by the Supervisor, should be submitted to the Head of the Department.

Progress made by students will be continuously monitored & evaluated as per the approved procedure.

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Semester - VII

(Departmental Core Subject)

CM-451 L-T-P-C

Transport Phenomena 3-1-0-4

Objective: *To impart knowledge about individual and simultaneous momentum, heat and mass transfer, model development along with appropriate boundary conditions.*

Course Content

Transport by molecular motion: Newton's Law of viscosity, Fourier's law of heat conduction, Fick's law of diffusion. Transport in laminar flow or in solids in one dimension: development of continuity (conservation) equations, velocity, temperature and concentration profiles, momentum, energy, and mass fluxes. Equations of change for isothermal, non-isothermal, and multicomponent systems. Navier-Stokes equation, equation of energy, equations of motion for free and forced convection (heat/mass).Unsteady state viscous flow, heat conduction, and mass diffusion. Momentum, energy, and mass transport in boundary layer with relevant analogies. Transport in turbulent flow-times smoothened equations of change. Interphase momentum, heat, and mass transfer.

Text/Reference Book

1. Transport Phenomena, Revised 2nd Edition. R. Byron Bird, Warren E. Stewart & Edwin N. Lightfoot, John Wiley & Sons, Hoboken, NJ, 2007

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Semester - VII

(Departmental Core Subject)

CM-452 L-T-P-C

Mineral Beneficiation 3-1-0-4

Objective: *The main objective of the course is to learn the properties of coal and mineral and its implication on mineral beneficiation.*

Course Content

Exploitable characteristics of minerals. Economics of mineral beneficiation. Power laws. Principles of crushing and grinding. Grindability. Evaluation of particle size. Size distribution curves and their significance. Mechanism of breakage of material. Classification, design and application of crushers and grinders. Industrial screening, classification and performance of screens. Dry and wet classifiers. Free and hindered settling, Thickeners, hydro cyclones, filtration, agitation and mixing, tabling, jigging, magnetic and electrostatic separation. Surface behavior and flotation principles. Flotation machines, differential flotation and flotation circuit design. Elements of hydrometallurgy, microbial leaching etc. Important beneficiation circuits of minerals like chalcopyrites, sphalerite, galena, bauxite etc.

Text/Reference Book

1. Principles of Mineral Dressing. A. M. Gaudin. Publisher, Tata McGraw-Hill, 2001

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Semester - VII

(Departmental Core Subject)

CM-453 L-T-P-C

Process Equipment Design 3-1-0-4

Objective: *To understand the mechanical and process design methods for various process equipment.*

Course Content

Process and mechanical design of Mass Transfer Equipments: Binary distillation: process and equipment design of bubble-cap tray column.Gas Liquid Absorber (absorption without chemical reaction): process and equipment design of packed column.Cooling tower design, Crystalliser design, Design of driers.

Text/Reference Books

1. Chemical Engineering", Vol. I and II, Coulson, J.M. and Richardson, J.F., Asian Books Pvt., New Delhi
2. Unit Operations of Chemical Engineering, 6th ed, McCabe, W.L. Smith, J.C. and Harriot, P., McGraw-Hill, NY.

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Semester - VII

(Humanities & Basic Sciences Subject)

HU-451 L-T-P-C
Interview Skills 0-0-1-1

Objective: *To understand the intricacies of interview & develop skills to perform satisfactorily.*

Course Content

SWOT Analysis.

Significance of Etiquette, Grooming, Kinesics, Paralanguage & Proxemics in interviews.

Résumé, Cover letter, Thank you Letter, Job Acceptance Letter.

Interview types, Open-ended, Behavioural & Hypothetical questions, FAQs.

Group Discussion & Interview sessions.

Text/Reference Books

1. How to Succeed in Group Discussions and Personal Interviews. Mandal S. Jaico Publishers. 2004.
2. Cover Letters. Fein R. Jaico Publishers. 2005.
3. The Definitive Book of Body Language. Barbara P. Manjul Publishing House Pvt. Ltd. 2013.

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Semester - VII

(Humanities & Basic Sciences Subject)

MA-454 L-T-P-C
Quantitative Aptitude 0-1-0-1

Objective: *To introduce certain topics from quantitative aptitude with emphasis on analytical ability & computational skills needed in competitive examinations. This module would also train the students to solve quantitative aptitude problems during the placement drives.*

Course Content

Problems on Alligation or mixture. Problems on Ages. Problems on Clock. Problems on Calendar. Problems on Speed, Time & distance. Problems on Time & Work. Problems on Heights & distances. Problems on Trains. Problems on Boats & Streams. Problems on Pipes & Cisterns.

Text/Reference Books

1. Quantitative Aptitude. Aggarwal R. S. S. Chand. 2012.
2. Quantitative Aptitude. Trishna Knowledge Systems. Pearson. 2014.

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Semester - VII

(Management Subject)

BM-451 L-T-P-C
Ethics & IPR 2-0-0-2

Objective: *The aim of this course is to sensitize students towards professional ethics, values & associated aspects. It initially addresses concerns relating to product & service quality & then moves on to ethical aspects of organizational functioning. The course throws light on ethical issues & crimes that are likely to remain at the core of corporate concerns & discusses intellectual property related issues that are the need of modern industrial & business enterprises.*

Course Content

Role of Corporations: Some big changes in the world in last 60 years (WW II, GATT, WTO) & impact on business, Need for strategic planning & process management, Business strategies & challenges in leading global organizations.

Quality Management: Quality as a strategic imperative, Evolution of quality management, Distinction between quality control, quality assurance & quality management, International standards (ISO family of standards) & International models for quality management, quality in services, enhanced focus on accreditation, the accreditation process, standards for key services (food processing: HACCP & education: NAAC).

Ethics & Human Values: Ethics & morals values, Ethical theories, Common features of unethical companies & leaders, Professional ethics, Professional Codes of Ethics, Benefits & limitations of code of ethics, Corporate social responsibility & its business implications.

Intellectual Property Issues: Protecting the intangible, Evolution of knowledge as property, What are Intellectual property rights, Classification of intellectual property, Role of WTO & WIPO, The patenting process, Patent infringement, Copyrights, Requirements for registration of a copyright, Copyright infringement. Fair use of copyrighted material, Trade secrets, Reverse engineering, Protecting software.

Environmental & Health Concerns: Introduction, Manufacturing in the 21st century, Resource conservation, the social costs of environmental destruction (land, water & air pollution), ISO 14000 standards & approaches to environmentally friendly technology, carbon trading, international treaties & their limitations.

Text/Reference Books

1. Managing intellectual Capital: Organizational, Strategic and Policy Dimensions. Teece D. J. Oxford University Press. 2000.
2. Profiting from Intellectual Capital: Extracting Value from Innovation. Sullivan P.H. John Wiley. 1998.
3. Intellectual property law in India. Narang P.S. Georgia Law Agency. 2001.
4. ISO 9000 Quality systems Handbook. Hoyle D. 6th Ed. A Butterworth-Heinemann Title. 2009.
5. Implementing ISO 9000: 2015. Purushothama B. Edited. WPI Publishing. 2014.

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Semester - VIII

(Departmental Core Subject)

CM-454	L-T-P-C
Process Dynamics & Control	3-1-1-5

Objective: *Ability to develop mathematical and transfer function models for dynamic processes, analyze process stability and dynamic responses. Also to develop empirically determine process dynamics for step response data.*

Course Content

Dynamic behavior of linear systems and their control system design. Linear processes with difficult dynamics. Nonlinear process dynamics; phase-plane analysis; multiple steady state and bifurcation behavior; Process Identification; Controller design via frequency response analysis; Direct synthesis and Internal model control design; Cascade, feed forward and ratio control; Introduction to multivariable systems. Interaction analysis and multiple single loop controller design. Design of multivariable controllers; Controller design for nonlinear systems; Introduction to sampled-data systems; Tools of discrete-time systems analysis; Dynamic analysis of discrete-time systems; Design of digital controllers; Introduction to model predictive control; Convolution models; Model predictive control of MIMO systems

List of Experiments

1. Study of step response of Mercury-in-Glass thermometer
2. Study of control valve flow coefficient
3. Study of installed characteristics of control valve
4. Study of hysteresis of control valve
5. Study of step response of manometer

Text/Reference Book

1. Process Systems Analysis and control, Coughanowr, D.R., 2nd ed. McGraw-Hill, 1991.

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Semester - VIII

(Departmental Core Subject)

CM-456 L-T-P-C

Biochemical Technology 3-1-0-4

Objective: *To impact knowledge about biological and biochemical technology, with a focus on biological products, the design and operation of industrial practices.*

Course Content

Overview of industrial bioprocesses with emphasis on new material. Microorganisms/enzyme, metabolic pathway, yield, bioprocess, chemical engineering operations and applications. Solvents, enzymes, organic acids. Antibiotics, vitamins. Pharmaceutical products.

Text/Reference Books

1. Biochemical Engineering and Biotechnology Handbook, Atkinson, B. & Mavituna, F., Nature Press, Macmillan, 1983
2. Microbial Biotechnology: Fundamentals of Applied Microbiology, Glazer, A.N. & Nikaido, H., WH Freeman & Co., New York, 1995

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Semester - VIII

(Departmental Core Subject)

CM-470	L-T-P-C
Major Project	0-0-4-4

After completion of the Minor Project, students shall undertake the Major Project in the VIII Semester. The idea conceived in the Minor Project shall be executed in this semester under the supervision of the faculty member. Students shall complete the practical aspect of the project. Thereafter they will prepare a report, as per the prescribed format/ guidelines, incorporating the results, their analysis and interpretation. The report, duly certified by the Supervisor, should be submitted to the Head of the Department.

Progress made by the student will be continuously monitored and evaluated as per the approved procedure.

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Semester - VI

(Departmental Elective - I)

CM-359 L-T-P-C
Systems Engineering 3-0-0-3

Objective: *Understand the objectives of chemical process engineer in chemical industry*

Course Content

Overview Principles of system analysis; Creation and assessment of alternatives; Structure of systems; Interactions; Degrees of freedom; System information flow reversal; Digital encoding of system information flow; Selection of design variables and their structural effects; Decomposition of large scale systems through Block Diagram, Signal Flow Graph, and Matrix Algebra; Stability, sensitivity and determinancy of systems; Flow sheet simulation and recycle calculation; Optimization methods for single and multiple variables and techniques of systems optimization. Digital simulation in systems analysis and optimization

Text/Reference Book

1. Strategy of process engineering, Dale F. Rudd, Charles C. Watson. Published. New York : Wiley, 1995

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Semester - VI

(Departmental Elective - I)

CM-360	L-T-P-C
Non-Conventional Energy Sources	3-0-0-3

Objective: *To present a problem oriented in depth knowledge of Non-Conventional Energy Conversion Systems & to address the underlying concepts and methods behind Non-Conventional Energy Conversion Systems*

Course Content

Low temperature application of solar energy - solar hot water, solar drying, solar refrigeration, etc. Theory, performance analysis and testing of liquid flat plate collectors. Solar air heater and their design principles. Concentrating collectors-application and their designs. Thermal energy storage. Solar photovoltaic conversion. Biomass and their characteristics. Physical, thermochemical and biological methods of their conversion. Wind energy and their electric conversion. Tidal, geothermal and ocean thermal energy conversion systems

Text/Reference Books

1. Non-conventional energy sources, G.D. Rai, Khanna Publishers. New Delhi, 2001.
2. Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme, TMH, 2005.

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Semester - VI

(Departmental Elective - II)

CM-361 L-T-P-C
Green Technology 3-0-0-3

Objective: *The focus on reused/recycled sources and non-toxic techniques in design and fabrication; Design and build with reduced energy and maintenance as guiding forces.*

Course Content

Prevention of pollution; Atom economy; Less hazardous chemical syntheses; Designing safer chemicals; Safer solvent and auxiliaries; Design for energy efficiency; Use of renewable feedstock; Reduction of derivatives; Catalysis; Design for degradation; Real-time analysis for pollution prevention; Inherently safer chemistry for accident prevention

Text/Reference Book

1. Green Management and Green Technologies: Exploring the Causal Relationship by Jazmin Seijas Nogarida, 2008

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Semester - VI

(Departmental Elective - II)

CM-362 L-T-P-C
Polymer Engineering 3-0-0-3

Objective: *The student is expected to be able to demonstrate the macromolecular nature of polymers in industrial applications & Identify the importance of additives in plastics formulations.*

Course Content

Basic concept of polymer and polymer chemistry. Classification of polymers. Mechanism and kinetics of polymerization. Polymerization reaction engineering: emulsion polymerization, dispersion polymerization etc. Reactors for polymerization: analysis of polymerization reactions, Reactor design applied to polymer system, Average molecular weight of polymer in different reactor, Control of molecular weight. Rheology of polymeric system. Unit operations in polymer industries. Polymer processing: moulding, calendaring, extrusion etc.

Text/Reference Book

1. Fundamentals of polymer science and engineering, A. Kumar & S. K. Gupta, Tata-MacGraw Hill Publishing

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Semester - VII

(Departmental Elective - III)

CM-457 L-T-P-C
Industrial Pollution Control 3-0-0-3

Objective: *The course introduces various concepts of water efficiency and waste minimization in industrial sectors. Characterization and classification of different types of wastes are discussed along with existing norms for waste disposal.*

Course Content

Ecological systems and pollution. Fundamental definitions of pollution parameters - air and water quality criteria, Standards and legislation EIA, EIS and EMP. Air and water pollution management through waste minimization. Industrial air pollution management : air pollution meteorology (Generation, transportation and dispersion of air pollutants). Outlines of industrial air pollution control. Selection, design and performance analysis of air pollution control equipment : gravity settling chambers, air cyclones, ESPs, filters and wet scrubbers. Industrial water pollution management: Wastewater treatment processes; Pretreatment, primary and secondary treatment processes. Advanced wastewater treatment processes. Design of sedimentation tanks and biological treatment processes.

Text/Reference Book

1. Environmental Science & Engineering, J.G. Henry & G. W. Heike, Prentice Hall International Inc., New Jersy, 1996.

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Semester - VII

(Departmental Elective - III)

CM-458 L-T-P-C
Fundamental of Bioenergy 3-0-1-4

Objective: *This course objective is to understand the importance of renewable energy; knowledge of bioenergy and its development; technical aspect and benefits of bioenergy.*

Course Content

Earths energy budget and momentum transfer; Climate systems, Green House Gases, Energy challenge for emerging nations; Food vs. Fuel debate; Land use and Remote Sensing analysis; Bioenergy crops: second generation crops, new opportunities and synergies based on land analysis; Life Cycle Analysis. Biomass resources: Starch, Sugar, Lignocellulose, Oilseeds, Municipal Solid Wastes; Cellular Bioenergetic Pathways; Enzyme Kinetics, Immobilized Enzymes; Microbial and Fungal Growth; Design, Analysis and Stability of Bioreactors; Production of Cellulosic Fuels: effects of mass transport on reaction kinetics; Biodiesel production: kinetics and thermodynamics; Bio-hydrogen production: fermentation and photobiological methods; Bio-gas production: anaerobic digestion; Microbial Fuel Cells; By-product recovery and utilization

Text/Reference Book

1. Biofuels Engineering Process Technology, C. M. Drapcho, N.P. Nhuan, T.H. Walker, McGraw Hill, 2008.

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Semester - IV

(Open Elective - I)

HU-252 L-T-P-C
Language through Literature & Films 0-2-0-2

Objective: *To introduce the nuances of English Literature & develop reflective, creative & literary abilities.*

Course Content

Ruskin Bond -The Eyes Have It.

Sudha Murthy - Appro JRD.

Bacon - Of Studies; Of Youth and Age.

Douglas Malloch - Be the best of whatever you are.

Rabindranath Tagore - Where the mind is without fear.

Enhancement of emotional, creative & social quotient through viewing & discussions on selected films.

Text/Reference Book

1. Literature and Language Teaching: A Guide for Teachers and Trainers. Lazar G. Cambridge University Press. 2008.

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Semester - IV

(Open Elective - I)

BM-270 L-T-P-C
Foundations of Economic Science 2-0-0-2

Objective: *The objective of this course is to teach basic principles of consumption production, exchange, distribution of remuneration to factors, pricing & public finance. Further, students are provided knowledge on completion of projects by optimizing production with limited resources & also to know infrastructure & development needs of a country to perform tasks accordingly.*

Course Content

Engineers & Economics: Meaning of economics, why engineers should know economics, important basics: consumption, production, exchange, distribution & public finance, cost of production & revenue through sales.

Consumption & Pricing: Cardinal & Ordinal approach to Utility, Laws of Diminishing Marginal Utility & Equi-marginal Utility, Demand: Meaning, Law, Types, Elasticity of Demand: Meaning & Degrees. Laws of Supply, Pricing of all products: Theory & practice.

Factors of Production & Markets: Land, Labour, Capital, Organization & Enterprise, Laws of Returns, Classification of Markets: Perfect & Imperfect competition including Monopoly, Discriminative Monopoly & Oligopoly.

Financial Aspects of Engineering: Money & Finance, An overview of Banking, Money Market, Capital Market, Public Finance & Private Finance, Direct & Indirect Taxes, Canons of Taxation, National Income.

Developmental Aspects of Engineering: Underdevelopment, Stages of economic development, Economic Growth, Growth Theories Economic Reforms: LPG. Application of financial accounting techniques for engineering projects.

Text/Reference Books

1. Textbook of Economic Theory. Stonier A. W. & Hague D. C. 5th Ed. Longman Higher Education. 1980.
2. Introduction to Positive Economics. Lipsey R. G. & Chrystal K. A. 8th Ed. Oxford University Press. 1995.
3. Business Economics (Micro). Shankar G. Nirali Prakashan. 2014.
4. Micro Economic Theory. Jhingan M. L. 7th Ed. Vrinda Publications Pvt. Limited. 2014.
5. Managerial Economics. Theory and Application. Mithani D. M. 7th Ed. Himalaya Publishing House Pvt. Ltd. 2013.
6. Micro economics. Pindyck R. S., Rubinfeld D. L. & Mehta P. L. 7th Ed. Pearson Education India. 2009.

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Semester - V

(Open Elective - II)

HU-351 L-T-P-C
Fun with Drama 0-2-0-2

Objective: *To stimulate imagination, cultural enrichment & explore multidimensional use of language through drama.*

Course Content

Script writing: Story, structure, character development, dialogue, visuals & language with emphasis on critical & analytical thinking, problem-solving & communication skills.

Direction: Techniques & art of play direction with emphasis on methods of actor coaching, rehearsal procedures & presentation of several scenes of varying dramatic styles.

Enactment: Controlled use of body & voice, analysis & interpretation of roles, characterization & emotional projection.

Analysis: Insightful analysis of various aspects of translating a play from script to stage, director's concepts, visual composition, attention to character development & narrative structure & power of the unspoken word.

Text/Reference Books

1. Drama Techniques in Language Learning. Maley A. & Duff A. 3rd Ed. Cambridge University Press. 2005.
2. Drama (Resource Book for Teachers). Wessels C. Oxford University Press. 1987.

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Semester - V

(Open Elective - II)

BM-370 L-T-P-C
Marketing Management 2-0-0-2

Objective: *Marketing is no longer a department charged with a limited number of tasks - it is a companywide undertaking. Marketing succeeds only when all departments work together to achieve goals. The syllabus is designed to serve as an introduction to the theory & practice of marketing to the engineering students. It will help them develop competencies in the use of the modern marketing techniques & their applications in design, development & commercialization of new products & services in the rapidly changing markets.*

Course Content

Introduction: Nature & scope of marketing; Importance of marketing as a business function; Marketing concepts – traditional & modern; Selling vs. marketing; Marketing mix & environment, Marketing Myopia.

Consumer Behaviour & Market Segmentation: Significance of consumer behavior; Market segmentation; concepts & importance; Bases for market segmentation.

Product: Concept of product, consumer & industrial goods; Product planning & development: Product life cycle concept, New Product Development, Product Differentiation & Positioning.

Branding: Role of brand & its Significance, Types of Brands, Challenges for Brands, Brand Equity.

Price: Importance of price in the marketing mix; Factors affecting price of a product/ service.

Distributions: Distribution channels; concept & role; Types of distribution channels; Factors affecting choice of a distribution channel.

Communications: Techniques of promotion; Integrated Marketing Communications; Advertising: Role & Significance. Media & their relative merits & limitations, Public Relations & Personal Selling.

E-marketing management: Overview of e-commerce, E-marketing: Role of IT in marketing, E-Marketing-mix, Emerging technology trends & their implications for marketing, Social media & marketing, E-CRM & building relationship.

Text/Reference Books

1. Marketing Management- A south Asian Perspective. Kotler P., Keller K., Koshy A. & Jha M. 12th Ed. Pearson Education. 2007.
2. Marketing Management. Kotler P. & Keller K. Prentice Hall. 2003.
3. Fundamentals of Marketing. Stanton W. J., Michael E. J. & Walker B. J. McGraw-Hill International. 1997.
4. Principles of Marketing. Kotler P. & Armstrong G. Pearson Education. 2007.
5. Fundamentals of Marketing. Stanton W. J. 5th Ed. McGraw-Hill, New York. 1978.
6. Marketing Environment: Planning, Implementation and Control, the Indian context. Ramaswamy V. S. & Namakumari S. Mcmillan. 1990.

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Semester - VII

(Open Elective - III)

BT-471 L-T-P-C
Bioprocess Technology 3-0-0-3

Objective: *A* bioprocess *is a specific process that uses complete living cells or their components to obtain desired products which is an importance part of biotechnology industry. This course is designed to make a learner efficient in bioprocess calculations & to impart knowledge of different technology used in bioprocess.*

Course Content

Bioprocessing v/s chemical processing, Substrates for bioconversion processes Inoculum development. Process technology for production of primary metabolites: such as baker's yeast, ethanol, citric acid, amino acids, polysaccharides & plastics, Microbial production of industrial enzymes such as glucose isomerase, cellulase, amylase, protease etc., Production of secondary metabolites: penicillin & cephalosporin etc.

Text/Reference Books

1. Encyclopedia of Bioprocess Technology. Michael F. & Stephen D. John Wiley & Sons.1999.
2. Principles of Fermentation Technology. Stanbury P. F., Whitaker A. & Hall S. J. 2nd Ed. Elsevier.1995.
3. Microbial biotechnology: Fundamentals of Applied Microbiology. Glazer A. N. & Nikaido H. 2nd Ed. W.H. Freeman & Company. 1995.

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Semester - VII

(Open Elective - III)

CE-462 L-T-P-C
Air Pollution & Industrial Waste Management 3-0-0-3

Objective: *To give understanding of air pollution & its impact, modeling of dispersion of pollutant, control measures, types of waste from different industries & their management.*

Course Content

Air Pollutants, their sources & harmful effects on the environment; Meteorology as applied to air pollution & dispersion of air pollutants, Air quality & emission standards, Removal of gaseous & particulate matter. Sources & types of wastes; solid, liquid & gaseous wastes; Water use in industry, industrial water quality requirements; Control & removal of specific pollutants in industrial wastewaters from dairy, fertilizer, distillery, tannery, sugar, pulp & paper, iron & steel, metal plating etc.

Text/Reference Books

1. Air Pollution-Its Origin and Control. Wark K. & Warner C. F. Harper & Row New York. 1981.
2. Air Pollution Control Engineering. Nevers N. D. McGraw-Hill International Ed. 1985.
3. Zero Pollution for Industry: Waste Minimization through Industrial Complexes. Nemerow N. L. John Wiley & Sons.1995.
4. Liquid Waste of Industry: Theoy, Practices and Treatment. Nemerow N L. Addison-Wesley. 1971.
5. Wastewater Treatment for Pollution Control. Arceivala S. J. Tata McGraw-Hill. 1999.
6. Industrial Water Pollution Control. Eckenfelder W. W. McGraw-Hill. 2000.

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Semester - VII

(Open Elective - III)

CM-459 L-T-P-C

Hazard Analysis & Risk Management in Chemical Industry 3-0-0-3

Objective: *This course will give an overview of the safety regulations and practices, plant hazards and their control, risk management principles and techniques and accident analysis.*

Course Content

Introduction to Material Safety Data Sheet (MSDS)Hazard and its classification - environmental, personal, and plant and equipment related issues; Regulatory bodies and regulations; Plant layout Safety by design- sizing of specific devices such as, safety release valves, vents, flare systems; Instrumentation for safety - specific devices such as alarms, interlocks, shutdown systems Economic aspects of safety; Operational safety-commissioning, safe start-up and safe shut-down of equipment such as, distillation column, furnace, reactor, pumps and compressors Failure probability estimation methods; Fault Tree Analysis; HAZOP; HAZAN Case studies from various sectors of chemical industry, such as, refinery, bulk chemicals, pesticides

Text/Reference Book

1. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, Joseph F. Louvar, - Prentice Hall, 2002

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Semester - VII

(Open Elective - III)

CS-462 L-T-P-C
Management Information Systems & E-Commerce 3-0-0-3

Objective: *The course aims at acquainting students with the fundamentals of information systems & their application in the various areas of business. It also provides an overview of the emerging domain of e-commerce, its concepts, issues & technologies.*

Course Content

Management Information Systems: Need, Purpose & Objectives- Contemporary Approaches to MIS: Business processes & Information Systems –Information systems function in Business-Use of Information Systems for competitive advantage - MIS as an instrument for the organizational change: Management issues – Types of Business Information Systems.

Enhancing Decision Making: Information, Management & Decision Making - Models of Decision Making - Classical, Administrative & Herbert Simon's Models - Attributes of information & its relevance to Decision Making - Types of information, Decision Support Systems - Group Decision Support Systems –- Executive Support Systems

E-commerce: Introduction, Definition of e-commerce, emergence of Internet, commercial use of Internet, history of e-commerce, advantages & disadvantages of e-commerce.

Business models for e-commerce: B2C, B2B, C2C, C2B, brokerage model, aggregator model, info-mediaries, communities, value-chain model, manufacturer model, advertising model, subscription & affiliate model.

Enabling technologies: Internet Client server applications, networks, Uniform Resource Locator (URL), search engines, software agents, Internet Service Providers(ISP), broadband technologies, Electronic Data Interchange(EDI).

E-marketing: characteristics, methods, e-marketing value-chain, site adhesion, browsing behavior model, e-advertising, e-branding, e-marketing strategies.

E-security: Security risks, risk management issues, legal & ethical issues, security mechanisms, encryption, digital signature, digital certificates.

E-payment systems: token-based system, card-based system, e-cash. E-cheque, e-banking, risks, data protection.

Text/Reference Books

1. Management Information Systems. Laudon & Laudon, 7th Ed. Pearson Education Asia.
2. E-commerce: An Indian Perspective. Joseph P. T. 2nd Ed. Prentice Hall India. 2007.
3. Management Information Systems. Bagchi N. 1st Ed. Vikas Publishing. 2010.

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Semester - VII

(Open Elective - III)

EE-465 L-T-P-C
Energy Conversion Process 3-0-0-3

Objective: *To get acquainted the students with various energy conversion processes used in non-conventional energy sources.*

Course Content

Physics of photovoltaic energy conversion in P-N junctions. Effect of physical properties of photovoltaic converters; Performance characteristics of different types of photovoltaic devices; Design considerations & manufacturing processes; Regulations & efficiency of conversion. Charge carriers & thermoelectric phenomena; Thomson, Peltier, Seebech effect; Kelvin's relations; Thermoelectric energy conversion; Materials, size & capacity; Performance analysis & optimized design of thermoelectric devices. Physics of thermionic emission; Operation of high level vacuum & low pressure thermionic converters; Vacuum & gas-filled converters; Thermionic nuclear reactors; Heat pipes. Basic principles of Magneto hydrodynamic power generation; Hall effect; Ionization & seeding; Faraday, Segmented electrode, Hall & Cross-connected generators, Open & closed cycles; Liquid metal MHD. Fuel cells, Thermodynamics of Fuel Cells. Performance Analysis. Low, medium, high temperature Fuel Cells.

Text/Reference Books

1. Energy Conversion Systems. Begamudre R. D. 1st Ed. New Age Pub. 2000.
2. Solar PV and Wind Energy Conversion Systems: An Introduction to Theory, Modeling with MATLAB/SIMULINK & the Role of Soft Computing Techniques (Green Energy and Technology) Sumathi S., Kumar A. L. & Surekha P. Springer. 2015.

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Semester - VII

(Open Elective - III)

ME-465 L-T-P-C
Solar Energy & Applications 3-0-0-3

Objective: *This course discusses solar energy as an important alternative to conventional sources of energy- its generation & utilization.*

Course Content

The energy crisis- causes & options, renewable & non-renewable forms of energy & their characteristics, solar energy option availability & land area requirements. Solar radiation outside the earth atmosphere & at the earth`s surface, instruments for measuring solar radiation, solar radiation geometry, basic earth-sun angles, fluxon tilted surfaces. Liquid flat-plate collectors design & performance parameters, solar air heaters, concentrating collectors, solar ponds & energy storage. Solar thermal power generation: low, medium & high temperature cycles, solar cooling, drying & desalination, solar air & water heating, solar passive architecture. Solar photovoltaic power generation: mono crystalline, polycrystalline & amorphous cells, Fabrication & performance of SPV modules. Indirect methods of solar energy utilization: biomass, wind, wave &ocean thermal energy conversion technologies. Economic considerations.

Text/Reference Books

1. Solar Energy principles of thermal collection and storage. Sukhatme. Tata McGraw-Hill.1996.
2. Solar Energy fundamental sand applications. Garg & Prakash. Tata McGraw-Hill. 1997.

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Semester - VII

(Open Elective - III)

PH-451 L-T-P-C
Nanotechnology 3-0-0-3

Objective: *The objective of this course is to discuss why & how changes occur in the properties of bulk materials when their size approaches a billionth of a meter & to understand the basics of nanostructures, nanotubes, nano-electronic devices, nanobiotechnology, nanomachines etc.*

Course Content

Basics of low dimensional (0D, 1D, 2D) structures, Quantum dots wires & wells, Nanoparicles-free & dispersed, Nanocrystalline & nanostructured films, Self-organized structures; Nanostructures for optical & electronic applications, Quantum dot diodes, lasers & detectors, Single electron devices & logic applications, Optical computing & Information processing; Carbon based nanostructures, Electrical, mechanical & chemical properties of carbon nanotubes, Sensors & drug delivery vehicles, Data processing; Bulk nanostructured material & Photonic crystals; Nanostructures for Magnetic applications, Giant & Colossal Magnetoresistance. Nanostructured ferromagnetism, Random Access Memories; Nanostructures for catalysis & hydrogen storage, Nanoclays, colloids & hydrogen storage nano materials. Organic & Biological nanostructures. Nanomachines & supra molecular devices.

Text/Reference Books

1. Introduction to Nanotechnology. Poole Jr. C. P. & Owens F. J. 1st Ed. Wiley-India Edition. 2007.
2. Nanotechnology: Principles & Practices. Kulkarni S. K. 3rd Ed. Springer. 2014.
3. Introduction to nanoelectronics. Mitin V. V., Kochelap V. A. & Stroscio M. A. 1st Ed. Cambridge University Press. 2007.
4. Nanoelectronics & Nanosystems. Goser K., Glosekotter P. & Dienstuhl J. 2nd Ed. Springer. 2009.

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Semester - VII

(Open Elective - III)

PH-453 L-T-P-C
Chaos in Engineering Systems 3-0-0-3

Objective: *The objective of this course is to introduce the importance of nonlinearity & its ubiquity in engineering systems. The various techniques/tools used to understand the dynamics of nonlinear systems with examples from various engineering disciplines shall be discussed.*

Course Content

Introduction to chaos. Various examples of chaos in engineering systems, electrical systems (Van Der Pol oscillator); Fluid mechanical systems (Lorenz equations, Aeroelastic flutter), Vibration (Duffing equation), Chemical reactions (Belousov-Zhabotinski reaction) etc. Basic concepts in the mathematical treatment of non linear systems. Note: The emphasis in this course will be on developing a physical understanding of chaotic systems. There will be computer simulation demonstration.

Text/Reference Books

1. Chaos and Non-linear dynamics. Hilborn R. 2nd Ed. Oxford University Press. 2001.
2. Non-linear dynamics and chaos. Strogatz S. H. 1st Ed. Perseus books. 2001.
3. Non-linear dynamics. Lakshmanan M. & Rajsekar S. 1st Ed. Springer. 2003.

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Semester - VIII

(Open Elective - IV)

BT-475 L-T-P-C
Bioremediation Technology 3-0-0-3

Objective: *This course is designed to learn advance technology which use microorganisms & plants to remediate polluted & contaminated sites e.g. Industrial waste water, sewage etc. as well as to make students learn about emerging technologies in this area.*

Course Content

General Introduction, toxic chemicals in the environment, Xenobiotic compounds, Properties, toxicity & types of toxicity, classification of toxicants in environment; atmospheric toxicants; Conventional remediation, thermal, chemical & physical processes, role of microorganisms in pollutant degradation, Bioremediation: process, classification: *In situ* & *Ex situ* bioremediation; constrains & priorities of bioremediation; evaluation of bioremediation; factors affecting process of bioremediation, methods in determining biodegradability; contaminant availability for biodegradation. Microbial remediation & phytoremediation, Impact of biotechnology on bioremediation & global application of bioremediation technologies & case studies, Emerging Environmental Biotechnologies: Bioleaching, Biosorption Biotransformation, Biomonitoring, Microbial fuel cells.

Text/Reference Books

1. Cell biology, Genetics, Molecular Biology Evolution & Ecology. Verma P. S. & Agarwal V. K. S. Chand publication. 2005.
2. Environmental Biotechnology. Shrinivas T. New Age International (P) Limited. 2008.

3. General Microbiology. Stanier R.Y., Michael D. & Edward A. 2nd Ed. McMillan Publications. 1989.
4. Environmental Biotechnology. Foster C. F. & John W. D. A. Ellis Horwood Ltd. 1987.
5. Biotechnology & Biodegradation: Advances in Applied Bitoechnology Series. Karrely D. Vol -4. Gulf Publications Co. 1989.
6. Bioremediation engineering; design & application. John C.1st Ed. McGraw-Hill.
7. Introduction to Envionmental Biotechnology. Chatterjee A. K. 3rd Ed. PHI Learning Pvt. Ltd. 2011.
8. Environmental Biotechnology. Joganand S. N. 4th Ed. Himalaya Publishing. 2015.

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Semester - VIII

(Open Elective - IV)

CE-464 L-T-P-C
Environmental Management 3-0-0-3

Objective: *To develop the understanding of various environmental management techniques, legal procedure in India, development of environmental friendly industries, environmental audits & concept of green buildings.*

Course Content

The need for environmental awareness & protection in both natural & man-made systems – effects on atmosphere, water, ecological systems & quality of life. Environmental Impact Assessment & Integrated Environmental Management, Practical applications – cradle to grave concept, life cycle analysis & clean technologies. Environmental Audit, Compliance Audit; Concept of ISO & ISO 14000. Needs of developing countries. Governmental standards for Environmental Protection. Emerging Global Environmental Issues. Environmental Legislation.

Text/Reference Books

1. Environmental Impact Analysis Handbook. John R. G. & David W. C. McGraw-Hill. 1980.
2. Environmental Management in South Africa. Fuggle R. F. & Rabie M. A. Juta & Co. Ltd., Johannesburg. 1991.
3. Pollution – Causes, Effects and Control. Harrison R. M. WhitstableLithop Ltd. 1990.
4. Environmental Impact Assessment. Canter L. W. McGraw-Hill. 1996.

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Semester - VIII

(Open Elective - IV)

CS-459 L-T-P-C
Statistical Simulation & Data Analysis 3-0-0-3

Objective: *The course is designed to discuss the methods to simulate the statistical inferences obtained from the various datasets. The course discusses the various data analysis methods available & their usage in generating inference from the datasets.*

Course Content

Introduction to probability distributions. Basics of estimation & testing of hypothesis (frequentist approach, Bayesian approach).

Different censoring schemes: Type-I, Type-II, hybrid, progressive. Different models & EM algorithm: mixture model; bivariate distributions; cure rate model; competing risk model.

Generating random sample: discrete & continuous multivariate distributions (multinomial, multivariate normal, multivariate exponential); acceptance rejection principle; Monte Carlo markov chain (metropolis Hastings algorithm, Gibbs sampler); Convergence of MCMC : Harris irreducibility, recurrence, minorization, limit theory for Harris recurrent markov chains.

Resampling techniques: jackknife; bootstrap. Hidden Markov Model (forward-backward algorithm, Viterbi algorithm, Baum-welch algorithm). Artificial Neural Network: framework, topology (feed forward neural network, recurrent neural network), training of ANN (supervised, unsupervised, reinforced learning), robustness. Genetic Algorithm: single objective GA, multi-objective NSGA.

Text/Reference Books

1. Simulation. Ross S. M. 4th Ed. Academic Press. 2006.
2. Data Analysis and Decision Making. Albright S. C., Winston W. L., Zappe C. J., Hinrichs C. & Rogove J. South-Western Publisher. 2002.
3. Data Analysis, Optimization and Simulation Modeling. Albright B. 4th Ed. Cengage. 2012.

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Semester - VIII

(Open Elective - IV)

EC-473 L-T-P-C
Robotics & Automation 3-0-0-3

Objective: *To introduce the basic concepts, parts of robots & types of robots & to make the student familiar with the various drive systems for robot & various applications of robots, justification & implementation of robot.*

Course Content

Introductory Concepts: Introduction to robotics, robotics history & development, classification of robotics, robotics applications & current research trends in robotics. Basic Components of Robotics Systems: Robotics manipulators & mechanisms actuators-pneumatics, hydraulics & electrics, sensors classifications, internal & external sensors.

Kinematics: Introduction to robotic manipulators, position & orientation of object space, robots coordinate transforms, Forward position analysis, Denavit-Hartenberg representation & parameter calculation, inverse position analysis & parameter calculation.

Euler angles & computation of parameters for different robot configurations.

Statics: Force & moment balance, recursive calculation, equivalent joint torque.

Dynamics: Inertia properties, Euler-Lagrange formulation, Newton-Euler formulation, recursive Newton-Euler algorithm, dynamic algorithm, recursive robot dynamics.

Control: control techniques, second order linear system, feedback control system & performance of feedback control system, robotic joints & joint controller, non-linear trajectory control.

Motion planning: General consideration in path description & generation, Joint space planning, Cartesian space planning, position & orientation trajectory, point to point planning, continuous path generation.

Introduction to robotic vision, image representation & analysis, template matching edge detection, space analysis, prospective transformation, camera calibration, image compression techniques.

Text/Reference Books

1. Introduction to Robotics. Saha S. K. Tata McGraw-Hill. 2009.
2. Introduction to robotics: Mechanics and control. Craig J. J. Addition Wesley Longman Publishing Co. 1989.
3. Introduction to Robotics (Analysis, Control, Applications). Niku S. B. 2nd Ed. Wiley India. 2011.
4. Robot Dynamics & Control. Spong M. W. & Vidyasagar M. Wiley. 1989.
5. Industrial Robotics & Manufacturing Automation. Groover M. P. Tata McGraw-Hill. 1998.

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Semester - VIII

(Open Elective - V)

BT-472 L-T-P-C
Bioelectronics & Biosensors 3-0-0-3

Objective: *This course imparts the knowledge of Biosensors, types of biosensors & their applications in online monitoring of bioprocesses.*

Course Content

Biosensors: components of biosensors, advantages & limitations; types of biosensors; biocatalysis based biosensors, bioaffinity based biosensors & microorganisms based biosensors, biologically active material & analyte. Types of membranes used in biosensor constructions. Design of enzyme electrodes & their applications as biosensors in industry such as health care & environment**.** Transducers in biosensors: piezoelectric, semiconductor, impedimetric, mechanical & molecular electronics based transducers. chemiluminiscene - based biosensors principles & applications; calorimetric, optical, potentiometric / amperometric conductrometric / resistormetric transducers; biosensors in clinical chemistry, medicine & health care, biosensors for veterinary, agriculture & food. Low cost- biosensor for online & environmental monitoring, Molecular electronics**,** assembly of photonic biomolecular memory store, information processing; commercial prospects for biomolecular computing systems.

Text/Reference Books

1. Biosensors for Environmental Monitoring. Bilitewski U. & Turner. A. P. F. Harwood. 2000
2. Biotechnology the Science & Business. Harwood, Moses V. & Cape. R. E. Academic Publisher London.1991
3. Biosensors for Analytical Monitoring. Rogers K. R. & Mascini M. EPA Biosensors Group. 2001.

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Semester - VIII

(Open Elective - V)

CS-461 L-T-P-C
Soft Computing 3-0-0-3

Objective: *This course deals with soft computing concepts, neural networks, fuzzy logic, use of heuristics based on human experience, genetic algorithm & its applications to soft computing , optimization problems to text analytics.*

Course Content

Introduction to Soft Computing: Rationale & Basics of Learning: Neural Networks: Multi-layer Feed-forward Networks, Recurrent Networks, Self-organizing Networks; Fuzzy Logic: Basics, inference scheme, Neuro-Fuzzy systems; Evolutionary Algorithms: GA & Optimization, Evolutionary Systems, Genetic Programming; Introduction to Rough Sets, Rough-Fuzzy representations, Belief Networks; Principles of SVM; Research based applications.

Text/Reference Books

1. Soft Computing: Fundamentals and Applications. Pratihar D. K. Narosa. 2015.
2. Neuro Fuzzy and Soft Computing. Jang J. S. R., Sun C. T. & Mizutani E. PHI. 2004.
3. Principles of Soft Computing. Sivanandam S. N. & Deepa S. N. 2nd Ed. Wiley. 2007.

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Semester - VIII

(Open Elective - V)

EE-466 L-T-P-C
Hydro Power Generation 3-0-0-3

Objective: *To get acquainted the students with various factors & control of hydro power plants.*

Course Content

Types of Hydro plants subsystems of hydro plant, turbines, hydro alternates hydro plant. Auxiliaries, control of hydro power, micro hydel systems & special problems in hydro plants.

Text/Reference Books

1. Hydro Plant Electrical Systems. David C. M. HCI Publications. 1999.
2. Hydro-electric and Pumped Storage Plants. Jog M. G. 1st Ed. New Age Pub. 1989.

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Semester - VIII

(Open Elective - V)

MA-453	L-T-P-C
Mathematical Statistics	3-0-0-3
Pre-requisite	MA-254 / MA-451

Objective: *To introduce the fundamental techniques of Sampling, Estimation & Hypothesis testing & illustrate these techniques with applications.*

Course Content

Review of Random variables. Order Statistics. Random sampling**.** The Central Limit Theorem. Sampling Distribution related to normal distribution**.** Point estimation. Bais & mean square errors of point estimators. Properties of point estimation & Methods of estimation**.** Confidence intervals. Large sample & small sample confidence intervals. Hypothesis testing. Common large sample tests p values. Small sample hypothesis tests. Power of tests & Neyman-Pearson Lemma.

Text/Reference Books

1. Statistical methods (Vol. II). Das N. G. 1st Ed. McGraw-Hill. 2009.
2. Probability statistics and random processes. Veerarajan T. 3rd Ed. Tata McGraw-Hill Education. 2008.
3. Higher Engineering Mathematics. Ramana B. V. 1st Ed. Tata McGraw-Hill Education. 2006.
4. Fundamentals of mathematical statistics. Gupta S. C. & Kapoor V. K. 11th Ed. S. Chand & Sons. 2002.

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Semester - VIII

(Open Elective - V)

ME-467 L-T-P-C
Total Quality Management 3-0-0-3

Objective: *This course discusses total quality is a description of the culture, attitude & organization of a company that aims to provide & continue to provide its customers with products & services that satisfy the needs.*

Course Content

Quality Concepts: Evolution of Quality control, concept change, TQM Modern concept, Quality concept in design, Review off design, Evolution of proto type. Control on Purchased Product: Procurement of various products, evaluation of supplies, capacity verification, Development of sources, procurement procedure. Manufacturing Quality: Methods & Techniques for manufacture, Inspection & control of product, Quality in sales & services, Guarantee, analysis of claims.

Quality Management: Organization structure & design, Quality function, decentralization, Designing & fitting organization for different types products & company, Economics of quality value & contribution, Quality cost, optimizing quality cost, seduction programme. Human Factor in Quality: Attitude of top management, co-operation, of groups, operators attitude, responsibility, causes of operators error & corrective methods. Control Charts: Theory of control charts, measurement range, construction & analysis of R charts, process capability study & use of control charts.

Attributes of Control Charts: Defects, construction & analysis off-chart, improvement by control chart, variable sample size, construction & analysis of C-chart. Defects Diagnosis & Prevention : Defect study, identification & analysis of defects, corrective measure, factors affecting reliability, MTTF, calculation of reliability, Building reliability in

the product, evaluation of reliability, interpretation of test results, reliability control, maintainability, zero defects, quality circle. IS0-9000 & its concept of Quality Management: ISO 9000 series, Taguchi method, JIT in some details

Text/Reference Books

1. Total Quality management. LaI H. Wiley Eastern Limited. 1990.
2. Beyond Total Quality Management. Bounds G. McGraw-Hill. 1994.
3. TQM in New Product manufacturing. Menon H. G. McGraw-Hill. 1992.