SEMESTER - I (Common for all B.Tech Courses)						
S. No	**C. Code**	**Course**	**L**	**T**	**P**	**C**
1	MA 101	Calculus	3	1	0	8
2	PH 101	Quantum Physics and Applications	2	1	0	6
3	CH 102	Fundamental Concepts and Applications of Chemistry	3	0	0	6
4	BB 103	Introduction to Modern biology	3	0	0	6
5	PH 113	Hands on Science Laboratory - I	0	0	3	3
6	CS 101	Computer Programming	3	0	2	8
7	HS 103	Introduction to Fine Arts	0	0	1	PP/NP
8	HS 106	Design Thinking and Creativity	1	0	0	PP/NP
9	NO107/ NO105	NSO/NSS	0	0	2	2
	First Semester Total Credits					39

1	**Title of the course** (L-T-P-C)	**Fundamental Concepts &Applications of Chemistry** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	**Organic and Inorganic** **(Inorganic): a. Harness the power of periodic table** Periodic properties: trends in size, electron affinity, ionization potential and electronegativity • Role of chemical elements in water contamination • Hardness of water • Desalination of brackish and sea water • Role of silicon in semiconducting applications • metal atom (Cu, Au, Pt, Pd etc.) based nanoparticles **b. Coordination complexes** Transition metal chemistry: inorganic complexes, bonding theories, magnetism, bonding aspects and structural distortion **(Organic):** **a. M.O. theory and π-conjugated compounds** Molecular orbitals of common functional groups, Qualitative Huckel MOs of conjugated polyenes and benzene. Aromaticity. Configuration, molecular chirality and isomerism, Conformation of alkanes and cycloalkanes **b. Polymers** Types and classification of polymers • polymerization techniques • Structure-property relationships of polymers • Conducting polymers **Physical Chemistry:** **a. Quantum chemistry** Schrodinger equation, Origin of quantization, Born interpretation of wave function, Hydrogen atom: solution to 🚒-part, Atomic orbitals, many electron atoms and spin orbitals. Chemical bonding: MO theory: LCAO molecular orbitals, Structure, bonding and energy levels of diatomic molecules. Concept of sp, sp^2 and sp^3 hybridization; Bonding and shape of many atom molecules; Intermolecular Forces; Potential energy Surfaces-Rates of reactions; Steady state approximation and its applications; Concept of pre-equilibrium; Equilibrium and related thermodynamic quantities **b. Electrochemistry** Electrochemical cells and Galvanic cells • EMF of a cell Single electrode potential • Nernst equation • Electrochemical series • Types of electrodes • Reference electrodes • Batteries • Modern batteries • Fuel cells • corrosion

4	**Texts/References**	1. J. D. Lee, "Concise Inorganic chemistry" 5th Edition. Wiley India. Ed. 2. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, "Inorganic Chemistry: Principles of structure and reactivity" 4th Edition, Person. 3. P. Atkins, J. de Paula, "physical chemistry" 5th Edition, Oxford. 4. J. Clayden, N. Greeves, S. Warren, "Organic chemistry" 2th Edition, Oxford. 5. George Odian, Principles of polymerization, 4th edition, Wiley student edition, Wiley India Pvt Ltd. 6. F. W. Billmeyer, Text book of Polymer Science, 3rd edition, Wiley student edition, Wiley India Pvt Ltd. 7. A. K. De, Environmental Chemistry, 8th edition, New Age International publishers. 8. B. K. Sharma, Environmental Chemistry, 16th edition, Krishna Prakashan Media Pvt Ltd. 9. A. R. West, Solid State Chemistry and Its Applications, Wiley student edition, Wiley India Pvt Ltd. 10. T. Pradeep, Nano: The essentials, McGraw-Hill Education publishers. 11. Geoffrey A Ozin and André Arsenault, Nanochemistry: A Chemical Approach to Nanomaterials, 2nd edition, RSC publishing.

Name of Academic Unit: Mathematics

Level: B. Tech.

Programme: B.Tech.

i	**Title of the course**	MA 101 Calculus
ii	**Credit Structure (L-T-P-C)**	(3-1-0-8)
iii	**Type of Course**	Core course
iv	**Semester in which normally to be offered**	Autumn
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any (For the students) – specify course number(s)**	--
vii	**Course Content**	Review of limits, continuity, differentiability. Mean value theorem, Taylors Theorem, Maxima and Minima. Riemann integrals, Fundamental theorem of Calculus, Improper integrals, applications to area, volume. Convergence of sequences and series, power series. Partial Derivatives, gradient and directional derivatives, chain rule, maxima and minima, Lagrange multipliers. Double and Triple

		integration, Jacobians and change of variables formula. Parametrization of curves and surfaces, vector fields, line and surface integrals. Divergence and curl, Theorems of Green, Gauss, and Stokes.
viii	**Texts/References**	1. B.V. Limaye and S. Ghorpade, A Course in Calculus and Real Analysis, Springer UTM (2004) 2. B.V. Limaye and S. Ghorpade, A Course in Multivariable Calculus and Analysis, Springer UTM (2010) 3. James Stewart, Calculus (5th Edition), Thomson (2003). 4. T. M. Apostol, Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern (1980). 5. Marsden and Tromba, Vector calculus (First Indian Edition), Springer (2012)
ix	**Name(s) of Instructor(s)**	BVL
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	NA
xi	**Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.**	No
xii	**Justification/ Need for introducing the course**	This is a fundamental mathematics course which is essential for any branch of engineering

1	**Title of the course** (L-T-P-C)	**Quantum Physics and Applications** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	● Quantum nature of light: Photoelectric Effect and Compton Effect. ● Stability of atoms and Bohr`s rules. ● Wave particle duality: De Broglie wavelength, Group and Phase velocity, Uncertainty Principle, Double Slit Experiment. ● Schrödinger Equation. ● Physical interpretation of Wave Function, Elementary Idea of Operators, Eigen-value Problem. ● Solution of Schrödinger equation for simple boundary value problems. ● Reflection and Transmission Coefficients. Tunneling. ● Particle in a three dimensional box, Degenerate states. ● Exposure to Harmonic Oscillator and Hydrogen Atom without deriving the general solution. ● Quantum Statistics: Maxwell Boltzmann, Bose Einstein and Fermi Dirac Statistics by detailed balance arguments. ● Density of states. ● Applications of B-E statistics: Lasers. Bose-Einstein Condensation. ● Applications of F-D statistics: Free electron model of electrons in metals. Concept of Fermi Energy. ● Elementary Ideas of Band Theory of Solids. ● Exposure to Semiconductors, Superconductors, Quantum Communication and Quantum Computing.
4	**Texts/References**	1. Quantum Physics: R. Eisberg and R. Resnick, John Wiley 2002, 2nd Edition. 2. Introduction to Modern Physics: F. K. Richtmyer, E. H. Kennard and J.N. Cooper, Tata Mac Graw Hill 1976, 6th Edition. 3. Modern Physics: K. S. Krane, John Wiley 1998, 2nd Edition. 4. Introduction to Modern Physics: Mani and Mehta, East-West Press Pvt. Ltd. New Delhi 2000. 5. Elements of Modern Physics: S. H. Patil, Tata McGraw Hill, 1984. 6. Concepts of Modern Physics, A Beiser, Tata McGraw Hill, 2009.

1	**Title of the course** (L-T-P-C)	**Introduction to Modern Biology (2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Quantitative views of modern biology. Importance of illustrations and building quantitative/qualitative models. Role of estimates. Cell size and shape. Temporal scales. Relative time in Biology. Key model systems – a glimpse. Management and transformation of energy in cells. Mathematical view – binding, gene expression and osmotic pressure as examples. Metabolism. Cell communication. Genetics. Eukaryotic genomes. Genetic basis of development. Evolution and diversity. Systems biology and illustrative examples of applications of Engineering in Biology.
4	**Texts/References**	Campbell Biology 12th edition, Pearson publication by Lisa Urry,Michael Cain,Steven Wassserman

Name of Academic Unit: Computer Science and Engineering

Level: B. Tech.

Programme: B.Tech.

i	**Title of the course**	CS 101 Computer Programming
ii	**Credit Structure (L-T-P-C)**	(3-0-2-8)
iii	**Type of Course**	Core course
iv	**Semester in which normally to be offered**	Spring
v	**Whether Full or Half Semester**	Full

	Course	
vi	**Pre-requisite(s), if any (For the students) – *specify course number(s)***	Nil
vii	**Course Content**	This course provides an introduction to problem solving with computers using a modern language such as Java or C/C++. Topics covered will include: **Utilization**: Developer fundamentals such as editor, integrated programming environment, Unix shell, modules, libraries. **Programming features**: Machine representation, primitive types, arrays and records, objects, expressions, control statements, iteration, procedures, functions, and basic i/o. **Applications**: Sample problems in engineering, science, text processing, and numerical methods.
viii	**Texts/References**	1. An Introduction to Programming through C++, 1st edition, by Abhiram G. Ranade, McGraw Hill Education, 2014. 2. C++ Program Design: An introduction to Programming and Object-Oriented Design, 3rd Edition, by Cohoon and Davidson, Tata McGraw Hill, 2003. Other references 1. Thinking in C++ 2nd Edition, by Bruce Eckel (available online). 2. How to Solve It by Computer, by G. Dromey, Prentice-Hall, Inc., Upper Saddle River, NJ, 1982. 3. How to Solve _It (2nd ed.), by Polya, G., Doubleday and co, 1957. 4. Let Us C, by Yashwant Kanetkar, Allied Publishers, 1998.

		5. The Java Tutorial, Sun Microsystems, Addison-Wesley, 1999.
ix	**Name(s) of Instructor(s)**	--
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	NA
xi	**Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.**	No
xii	**Justification/ Need for introducing the course**	Basic course in problem solving using computers.

1	**Title of the course** (L-T-P-C)	**Introduction to Fine Arts: Urban Dance in India: A Brief & Partial Introduction in Theory & Practice**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Body and Movement, Classical Dance in India, Contemporaneity: Modern & Postmodern Forms & Modes of Sustenance for a Dancer, Experimenting, Making Your Own Dance Work (Dance-pieces)
4	**Texts/References**	--

1	**Title of the course** (L-T-P-C)	**Design thinking and Creativity** **(1-0-0-0)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	1.Problem Exploration- Students move around and find problems that need solutions. 2.They analyse the problem (not solution) and evolve a problem space. The problem space is converted into a story boar and presented in a poster session. 3.Feedback at the poster session is used to refine the problem definition(s). 4.Solution Exploration: Creative solutions (solution space) are now explored and presented using story boards. 5.The solutions are converted into "embodiments"
4	**Texts/References**	1."Stuff Matters" Prof. Mark Miodownik, Penguin 2. "Design and Technology" by James Garratt, Cambridge University Press. 3. How it works in the home: Walt Disney :9780894340482- Amazon.com. 4.How it works in the City (Walt Disney available on Amazon.com) 5.Change by design – Tim Brown There are some additional books in this "How it Works" series.

Semester II						
S. No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	MA 102	Linear Algebra	3	1	0	4
2	BB 201	Biomolecules	2	1	0	6
3	ME 111	Engineering Graphics Laboratory	1	0	3	5
4	ME 201	Engineering Mechanics	2	1	0	6
5	CS 201	Data Structures and Algorithms	3	0	0	6
6	CS 211	Data Structures and Algorithms Laboratory	0	0	3	3
7	ME 113	Hands on Engineering Laboratory	0	0	3	3
8	CL 101	Introduction to chemical Engineering	3	0	0	6
9	NO 105/ NO 107	National Sports Organization (NSO)/National Service Scheme (NSS)	0	0	2	2
		Total Credits				41

1	**Title of the course** (L-T-P-C)	**Linear Algebra** **(3-1-0-4)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Vectors in R^n, notion of linear independence and dependence, linear span of a set of vectors, vector subspaces of R^n, basis of a vector subspace. Systems of linear equations, matrices and Gauss elimination, row space, null space, and column space, rank of a matrix. Determinants and rank of a matrix in terms of determinants. Abstract vector spaces, linear transformations, matrix of a linear transformation, change of basis and similarity, rank-nullity theorem. Inner product spaces, Gram-Schmidt process, orthonormal bases, projections and least squares approximation. Eigenvalues and eigenvectors, characteristic polynomials, eigenvalues of special matrices (orthogonal, unitary, hermitian, symmetric, skew-symmetric, normal). Algebraic and geometric multiplicity, diagonalization by similarity transformations, spectral theorem for real symmetric matrices, application to quadratic forms.
4	**Texts/References**	1. H. Anton, Elementary linear algebra with applications (8th Edition), John Wiley (1995). 2. G. Strang, Linear algebra and its applications (4th Edition), Thomson (2006) 3. S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India (2000) 4. E. Kreyszig, Advanced engineering mathematics (10th Edition), John Wiley (1999)

1	**Title of the course** (L-T-P-C)	**Biomolecules** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	Major classes of biological molecules: Comparison of the alphabets and sources of structural diversity of proteins, nucleic acids, carbohydrates and lipids. Proteins: Ramachandran plot, evolution of protein structure, structure-function relationships: myoglobin and adaptations in myoglobin structure in deep diving mammals; allostery in hemoglobin; Bohr effect (for pH and carbon dioxide); adult and foetal hemoglobin. Post-translational modifications: special types of covalent bonds found in proteins. Protein folding: Natively folded and natively disordered proteins; miniproteins and peptide toxins; Anfinsen's observations, Levinthal paradox, cooperativity in protein folding, free energy landscape of protein folding and pathways of protein folding, molten globule state, diseases associated with protein folding. Carbohydrates: Sources of structural diversity; structure- function relationship in glycogen and cellulose, Difficulty associated with sequencing of glycans. Lipids: Structure and properties of storage and membrane lipids. Self-assembly of lipids: packing parameter; Biomembrane organization - sidedness and function; membrane bound proteins - structure, properties and function; transport phenomena. Nucleic acids: Historical perspective leading up to the proposition of DNA double helical structure with emphasis on the innovativeness of experimental design; Secondary structure of RNA; chromatin organization. Enzymes: General principles of catalysis; quantitation of enzyme activity and efficiency; Henri-Michaelis-Menten and Briggs-Haldane relationships; Transition state: definition Pauling's intuition and proposal, catalytic antibodies; Catalytic strategies; Isozymes: Haldane relationship between kinetic constants and equilibrium constant; Zymogens. Bioenergetics: basic principles; equilibria and concept of free energy; coupled interconnecting reactions in metabolism; oxidation of carbon fuels; recurring motifs in metabolism. Relevant metabolic pathways may be included to discuss relevant concepts.

4	**Texts/References**	1. Rodney F Boyer, Concepts in Biochemistry. John Wiley & Sons; 3rd Ed (2 December 2005). 2. Thomas Miilar, Biochemistry Explained: A Practical Guide to Learning Biochemistry CRC Press; 1 edition (30 May 2002) Lubert Stryer et al., Biochemistry.W. H. Freeman; 6th Edition edition (14 July 2006) 4. David L Nelson, and Michael M Cox et al., Lehninger principles of biochemistry WH Freeman; 7th ed. 2017 edition (1 January 2017)

1	**Title of the course** (L-T-P-C)	**Engineering Mechanics** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	--

3	**Course content**	**Module 1:** Introduction to Engineering Mechanics covering, Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy **Module 2:** Friction covering, Types of friction, Limiting friction, Laws of Friction, Staticand Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack; **Module 3:** Basic Structural Analysis covering, Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines; **Module 4:** Centroid and Centre of Gravity covering, Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook; **Module 5:** Virtual Work and Energy Method- Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium. Module 6: Particles dynamics- Kinematics of Particles: Rectilinear motion, Plane curvilinear motion - rectangular coordinates, normal and tangential coordinates, polar coordinates, Space curvilinear - cylindrical, spherical (coordinates), Relative and Constrained motion. Kinetics of Particles: Force, mass and acceleration – rectilinear and curvilinear motion, work and energy, impulse and momentum – linear and angular; Impact – Direct and Oblique. Kinetics of System of Particles: Generalized Newton's Second Law, Work-Energy, Impulse-Momentum, Conservation of Energy and Momentum Module 7: Introduction to Rigid body dynamics Kinematics of Planar Rigid Bodies: Equations for rotation of a rigid body about a fixed axis, General plane motion, Instantaneous Center of Rotation in Plane Motion Plane Motion of a Particle Relative to a Rotating Frame. Coriolis Acceleration Kinetics of Planar Rigid Bodies: Equations of Motion for a Rigid Body, Angular Momentum of a Rigid Body in Plane Motion, Plane Motion of a Rigid Body and D'Alembert's Principle, Systems of Rigid Bodies, Constrained Plane Motion; Energy and Work of Forces Acting on a Rigid Body, Kinetic Energy of a Rigid Body in Plane Motion, Systems of Rigid Bodies, Conservation of Energy, Plane Motion of a Rigid Body - Impulse and Momentum, Systems of Rigid Bodies, Conservation of Angular Momentum. Module 8: Mechanical Vibrations covering, Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums
4	**Texts/References**	**Textbooks:** 1. J. L. Meriam and L. G. Kraige, Engineering Mechanics, Vol I – Statics, Vol II – Dynamics, 6th Ed, John Wiley, 2008. 2. F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I - Statics, Vol II – Dynamics, 9th Ed, Tata McGraw Hill, 2011. R. C. Hibbler, Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press, 2006. References: 1. S. P. Timoshenko and D. H. Young, Engineering Mechanics. Fourth Edition. McGraw-Hill, New York, 1956. 2. I. H. Shames, Engineering Mechanics: Statics and dynamics, 4th Ed, PHI, 2002. 3. Robert W. Soutas-Little; Daniel J. Inman; Daniel Balint, Engineering Mechanics: Dynamics – Computational Edition, 1st Ed., Cengage Learning, 2007 4. Robert W. Soutas-Little; Daniel J. Inman; Daniel Balint, Engineering Mechanics: Statics- Computational Edition, 1st Ed., ,Cengage Learning, 2007

1	**Title of the course** (L-T-P-C)	**Engineering Graphics Lab** **(1-0-3-5)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Engineering Graphics with mini-drafter: Around half a semester and bit more with following topics to be covered. • Introduction to Engineering Graphics • Curves • Projections of Points • Projection of Lines • Projection of Planes • Projections on Auxiliary Planes • Projections of Solids • Sections of Solids • Intersections of Solids Engineering Graphics with 2D Drafting Software: 5 weekly computer laboratory sessions covering above using AutoCAD® as a drafting software, 5th session on Isometric Projections.
4	**Texts/References**	1. N. D. Bhatt, revised and enlarged by V. M. Panchal and P. R. Ingle, Engineering Drawing, 53rd Edition, 2014, Charotar Publishers, Anand. 2. Warren J. Luzadder and Jon M. Duff, Fundamentals of Engineering Drawing, Prentice-Hall of India. 3. Gopalakrishna K. R., Engineering Drawing Vol. I & II Combined., Subhas Stores, 25th Edition, 2017. 4. Narayana. K. L., and Kannaiah, P. E., Text Book on Engineering Drawing, 2nd Edition, 2013, Scitech Publications, Chennai. 5. Venugopal K. and Prabhu Raja V., Engineering Drawing + AutoCAD, New Age International Publishers, 5th Edition, 2011.

1	**Title of the course** (L-T-P-C)	**Data Structures and Algorithms** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Exposure to Computer Programming
3	**Course content**	Introduction: data structures, abstract data types, analysis of algorithms. Creation and manipulation of data structures: arrays, lists, stacks, queues, trees, heaps, hash tables, balanced trees, tries, graphs. Algorithms for sorting and searching, order statistics, depth-first and breadth-first search, shortest paths and minimum spanning tree.
4	**Texts/References**	1. Introduction to Algorithms, 3rd edition, by T. Cormen, C. Leiserson, R. Rivest, C. Stein, MIT Press and McGraw-Hill, 2009. 2. Data structures and algorithms in C++, by Michael T. Goodrich, Roberto Tamassia, and David M. Mount, Wiley, 2004.

1	**Title of the course** (L-T-P-C)	**Data Structures and Algorithms Laboratory** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	Exposure to Computer Programming (CS 102)
3	**Course content**	Laboratory course for CS 211 is based on creating and manipulating various data structures and implementation of algorithms.
4	**Texts/References**	1. Introduction to Algorithms, 3rd edition, by T. Cormen, C. Leiserson, R. Rivest, C. Stein, MIT Press and McGraw-Hill, 2009. 2. Data structures and algorithms in C++, by Michael T. Goodrich, Roberto Tamassia, and David M. Mount, Wiley, 2004.

1	**Title of the course** (L-T-P-C)	**Introduction to Chemical Engineering (3-0-0-6)**
2	**Pre-requisite courses(s)**	NIL
3	**Course content**	Historical overview of Chemical Engineering: Concepts of unit operations and unit processes, and more recent developments, Features of organized chemical processing- from chemistry to chemical engineering. The Chemical Industry-scope, features & characteristics. and scope. Principles of balancing with examples to illustrate differential and integral balances, lumped and distributed balances. Material balances in simple systems involving physical changes and chemical reactions; systems involving recycle, purge. and bypass. Properties of substances: single component & multicomponent, single and 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
4	**Texts/References**	1. R. M. Felder and R.W. Rousseau, Elementary Principles of Chemical Processes, 3rd ed., John Wiley, New York, 2004. 2. D. M. Himmelblau and J. B. Riggs, Basic Principles and Calculations in Chemical Engineering. 7th ed., Prentice Hall, 2003. 3. B. I. Bhatt and S. M. Vora, Stoichiometry. 4th ed., McGraw Hill, 2004.

Semester III						
S. No	Course Code	Course Name	L	T	P	C
1	CL 201	Introduction to Transport Phenomena	3	0	0	6
2	ME 207	Introduction to chemical engineering thermodynamics	3	0	0	6
3	ME 203	Fluid Mechanics	2	1	0	6
4	ME 222	Mechanics of Materials	2	1	0	6
5	EE 221	Introduction to Probability (1st Half)	3	0	0	3
6	EE 227	Data Analysis (2nd Half)	3	0	0	3
7	BB 301	Basics of Cell Biology and Genetics	3	0	0	6
8	CL 211	Chemical Engineering lab -I (Thermodynamics and fluid mechanics)	0	0	3	3
		Total Credits				39

1	**Title of the course** (L-T-P-C)	**Introduction to Transport Phenomena** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil

3	**Course content**	Introduction: Vectors/Tensors, Viscosity, Shell balance: Falling film, Circular tube; Equations of Change for isothermal systems: Continuity, Motion, Energy, Substantial derivatives; Unidirectional flows: Pipe flow, Variable viscosity falling film, Couette viscometer, Rotating Sphere; Unsteady flows: Startup Plate flow, Parallel plates, Oscillating plate; Thermal conductivity and mechanism of energy transport; Shell energy balances and temperature distributions in solids and laminar flow; The equations of change for nonisothermal systems; Diffusivity and the mechanisms of mass transport; Concentration distributions in solids and laminar flow; Equations of change for multicomponent systems; Introduction to the concept of heat and mass transfer coefficients.
4	**Texts/References**	1. R.B.Bird, W.E. Stewart and E.N. Lightfoot, Transport Phenomena, 2nd ed., Wiley, 2006

1	**Title of the course** (L-T-P-C)	**Thermodynamics for chemical engineers** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Thermodynamics introduction and basic definitions; Importance of PVT relation and equation of state; First law of thermodynamics, applications and limitations; Second law of thermodynamics and its applications; Irreversibility and availability; Thermodynamic potentials & property relations; Thermodynamic property estimation for ideal gas, real gas, and multicomponent mixtures; Solution thermodynamics: ideal and real solutions and the concept of excess properties; Phase equilibrium including vapor-liquid, liquid-liquid, and solid-liquid equilibrium; Chemical reaction equilibrium
4	**Texts/References**	i) Y V C Rao; "Chemical Engineering Thermodynamics" ii) Stanley I. Sandler "Chemical, Biochemical, and Engineering Thermodynamics 4th Edition" iii) J.M. Smith, H.C. Van Ness, M.M. Abott, M.T. Swihart “Introduction to Chemical Engineering Thermodynamics 8th Edition"

1	**Title of the course** (L-T-P-C)	**Fluid Mechanics** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Introduction :Scope, definition of fluid as continuum, fluid properties.(2hr) Fluid Statics: Pressure at a point, basic equation for pressure field, pressure variation(fluid at rest):standard atmosphere, Measurement of pressure manometer,Hydrostatics force on a plane and curve surface, Buoyancy, flotation and stability, pressure variation in a fluid with rigid body motion linear motion, rigid body rotation(4hr) Elementary Fluid Dynamics: Statics, stagnation pressure, Bernoulli Equation assumptions(4hr) Fluid Kinematics The velocity filed : Eulerian and Largrangian flow descriptions, steady and deformation, Acceleration field: material derivative, unsteady and convective effects. Control volume and system representation : Reynolds' Transport Theorem, physical interpretation, steady, unsteady effects, moving control volume, potential function(6Hr) Integral approach Conservation of mass derivation of continuity, fixed, non-deforming control volume, moving non-deforming control volume, deforming control volume. Conservation of momentum: linear momentum and moment of momentum equation and their application., comparison of energy equation with Bernoulli's equation(6hr) Differential approach : linear motion and angular motion with deformation, Conservation of mass: differential form of continuity equation, stream function, Conservation of linear momentum, Inviscid flows, Irrotational flow(6hr) Viscous flow : Stress relationships,NS Equations, Simple solutions for viscous flows(4hr) Dimensional analysis Buckingham's II-theorem,Dimensionless groups & their importance (3hr) Viscous Flow in Pipes : General characteristics of pipe flow, fully developed laminar and turbulent flow, turbulent shear stress, turbulent velocity profile, Pipe Flow rate measurement.(4hr) Boundary layer: Boundary layer characteristics boundary layer structure and thickness on a plate, Blasius boundary layer, momentum integral boundary layer equation for a flat plate(4hr)
4	**Texts/References**	1.Yunus A. Cengel, John M. Cimbala, Fluid Mechanics, Tata McGraw Hill Education,2011 2.F.M.White Fluid Mechanics, Seventh Edition, Tata McGraw Hill Education,2011, 3.Kundu,Pijush K., and Ira M.Cohen.Fluid Mechanic, Elsevier,2001

1	**Title of the course** (L-T-P-C)	**Introduction to Probability** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	Basic calculus

3	**Course content**	**Introduction**: Motivation for studying the course, revision of basic math required, connection between probability and length on subsets of the real line, probability-formal definition, events and σ-algebra, independence of events, and conditional probability, sequence of events, and *Borel-Cantell* Lemma. **Random Variables**: Definition of random variables, and types of random variables, CDF, PDF and its properties, random vectors and independence, brief introduction to transformation of random variables, introduction to Gaussian random vectors. **Mathematical Expectations**: Importance of averages through examples, definition of expectation, moments and conditional expectation, use of MGF, PGF and characteristic functions, variance and k-th moment, MMSE estimation. **Inequalities and Notions of convergence**: Markov, Chebychev, Chernoff and Mcdiarmid inequalities, convergence in probability, mean, and almost sure, law of large numbers and central limit theorem. **A short introduction to Random Process:** Example and formal definition, stationarity, autocorrelation, and cross correlation function, definition of ergodicity.
4	**Texts/References**	**1. Robert B. Ash**, ``Basic Probability Theory," Reprint of the John Wiley & Sons, Inc., New York, 1970 edition. **2. Sheldon Ross**, ``A first course in probability," Pearson Education India, 2002. **3. Bruce Hayek**, ``An Exploration of Random Processes for Engineers," Lecture notes, 2012. 4. D. P. Bertsekas and J. Tsitisklis, "Introduction to Probability" MIT Lecture notes, 2000 (*link*: https://www.vfu.bg/en/e-Learning/Math--Bertsekas_Tsitsiklis_Introduction_to_probability.pdf)

1	**Title of the course** (L-T-P-C)	**Data Analysis** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	Introduction to Probability

3	**Course content**	The role of statistics. Graphical and numerical methods for describing and summarizing data. Sampling variability and sampling distributions, Estimation using a single sample, Hypothesis testing using a single sample, Comparing two populations or treatments, Simple linear regression and correlation, and Case studies.
4	**Texts/References**	Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists," Elsevier, New Delhi, 3rd edition (Indian), 1987. Papoulis and Pillai, "Probability, Random Variables and Stochastic processes," 4th Edition, Tata McGraw Hill, 1991. William Feller , "An Introduction to Probability Theory and Its Applications," Vol. 1, 3rd edition, John Wiley International, 1968.

1	**Title of the course** (L-T-P-C)	**Basics of Cell Biology and Genetics (3-0-0-6)**
2	**Pre-requisite courses(s)**	None

3	**Course content**	1. QuantitaIntroduction to genetics 2. Mendelian genetics: Mendel's law and examples, Monohybrid and di- hybrid cross, recessive and dominant mutation, concept of allele 3. Non-Mendelian genetics: incomplete dominance, semi- dominance, and introduction to epigenetics, Cytoplasmic inheritance, infection heredity. 4. Genetic interactions: approach towards generating a network (epistasis, redundancy, synthetic lethality, lethal interactions) 5. Model organisms and studies on molecular and genetic interactions 6. Structure of prokaryotic and eukaryotic cells 7. Introduction of cell biology, classification of living organisms, Prokaryotic cells, eukaryotic cells. 8. Membrane structure and function. 9. Structure and Composition of the Cell Membrane, Membrane Proteins, Transport across the Cell Membrane. 10. Structural organization and function of intracellular organelles Structure and function of cytoplasm, Cytoskeletal elements and architecture, Structure and Function of mitochondria, Ribosomes, Endoplasmic reticulum, Rough endoplasmic reticulum and protein secretion, Lysosomes, The Golgi Complex, Peroxisomes, Vacuoles, plant cell organelles, Cell locomotion
4	**Texts/References**	Anthony JF Griffiths et al., An Introduction to Genetic Analysis W.H. Freeman and Co 7th Edition 2000 2. Watson et. al., Molecular Biology of the Gene, Pearson, 7th Edition 2013 3. Jocelyn E. Krebs et al., Lewin's Gene Jones & Bartlett Learning; 11 edition (December 31, 2012) 4. Richard Kowles, Solving Problems in Genetics Springer; 2001 edition (June 21, 2001) 4. Gerald Karp, Cell Biology, WILEY (Feb. 4th, 2013) 5. Bruce Alberts et al., Essential Cell Biology; Richard Goldsby and Thomas J, &F/Garland, 4th Edition, (2014) Alberts, Bruce.; Molecular Biology of the Cell, Garland Science; 5th edition (2 January 2008)

1	**Title of the course** (L-T-P-C)	**Chemical Engineering lab -1 (Thermodynamics and fluid mechanics) (0-0-3-3)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	*Thermoynamics*: Determination of partial molar enthalpies, vapour pressures, infinite dilution activity coefficient, vapour-liquid equilibrium, adiabatic calorimetry. *Fluid mechanics:* Flow visualization, Flow rate, velocity and pressure measurements, calibration of flow-meters, flow-through pipes and piping elements including Bernouli's principle, Impact of fluid-jets on substrates.
4	**Texts/References**	

Name of Academic Unit: Mechanical Engineering

Level: UG

i	**Title of the course**		**ME 222 Mechanics of Materials**
ii	**Credit Structure (L-T-P-C)**		2-1-0-6
iii	**Type of Course**		**Core**
v	**Whether Full or Half Semester Course**		Full
vi	**Pre-requisite(s), if any – specify course number(s)**		Nil
vii	Course Content	**Module 1:** Basics: Fundamentals of mechanics of deformable solids. Concepts of stress and strain and their relationships. Axially loaded members - Normal stress and strain, Simple (direct) shear stress and strain, Hooke's law, Stresses on inclined planes under axial loading, thermal stresses and strains, statically indeterminate problems. Elastic strain energy under axial loads. **Module 2:** Torsion: torsion of circular cross-section shafts (Solid and hollow sections): Deformation field, Torsion formulae for stresses and angular deflection, Elastic strain energy under torsion, Closely-wound helical springs – stresses and deflections. **Module 3**: Bending: Euler – Bernoulli model: normal and shear stresses, deflections for symmetric bending. Statically indeterminate problems, Elastic strain energy under flexure. **Module 4:** Combined stresses: State of stress and strain at a point , transformation laws , Mohr's circle diagram for stress and principal stresses, thin walled structures : thin cylinders and spheres. Theories of failure: Maximum Normal-Stress theory, Maximum shear-stress theory and Maximum Distortional-energy theory. **Module 5:** Energy methods – Castigliano's theorem and its applications, fictitious-load method. Stability of structures – Buckling of idealized and elastic columns	
viii	**Texts/ References**	**TEXTBOOKS:** 1) S.H Crandall, N.C Dahl and S.J Lardner, An Introduction to Mechanics of Solids, Tata McGraw Hill, Third Edition, 2012. 2) E.P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, 2nd edition, 2012. **REFERENCES:** 1. J. M. Gere and Goodno, Mechanics of Materials, 7th ed, Cengage Learning India, 2012. 2. J.P Den Hartog, Strength of Materials, Dover, 1949. 3. J.M Gere and S.P Timoshenko, Mechanics of Materials, CBS Publishers, 1986 4. R. C. Hibbeler, Mechanics of Materials, Pearson, 10th edition, 2016 . 5. S.P Timoshenko and D.H Young, Elements of strength of Materials, 5th ed, Affiliated East West Press, 1976. 6. F. P. Beer, E. R. Johnston Jr., John T. DeWolf , D. F. Mazurek, Mechanics of Materials, McGraw-Hill Education; 7th edition, 2014 7. M. Salvadori and R. Heller, Structure in Architecture, Prentice Hall Inc, 1963. 8. S.P Timoshenko, History of Strength of Materials, Dover, 1983. 9. M. H. Sadd, Elasticity: Theory, Applications, and Numerics, 1st ed, Elsevier India, 2006.	

Semester IV						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	ME 220	Heat Transfer	2	1	0	6
2	EE 101	Introduction to Electrical Systems and Electronics	3	0	0	6
3	MA 208	Introduction to Numerical Linear Algebra	3	1	0	4
4	MA 103	Differential Equations - I	3	1	0	4
5	BB 404	Biophysics	3	0	0	3
6	CL 202	Reaction engineering	3	0	0	6
7	CH 201	Organic Chemistry	3	0	0	3
8	CL 203	Mass transfer	3	0	0	6
		Total Credits				38

1	**Title of the course** (L-T-P-C)	**Heat Transfer** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• Introduction: Typical heat transfer situations, Modes of heat transfer, Introduction to laws, some heat transfer parameters • Conduction: Fourier's law and thermal conductivity, Differential equation of heat conduction, boundary conditions and initial conditions, Simple one dimensional steady state situations – plane wall, cylinder, sphere (simple and complex situations), concept of thermal resistance, concept of U, critical radius. variable thermal conductivity (exercise), Special one dimensional steady state situations: heat generation, pin fins, Other fin configurations (exercise), Two dimensional steady state situations, Transient conduction, Lumped capacitance model, One dimensional transient problems: analytical solutions, 1D Heisler charts, Product solutions, Numerical methods in conduction, Steady state 1D and 2D problems, 1D transient problems: Explicit and implicit • Radiation: Basic ideas, spectrum, basic definitions, Laws of radiation, black body radiation, Planck's law, Stefan Boltzman law, Wien's Displacement law, Lambert cosine law, Radiation exchange between black surfaces, shape factor, Radiation exchange between gray surfaces – Radiosity-Irradiation method, Parallel plates, Enclosures (non-participating gas), Gas radiation Forced Convection: Concepts of fluid mechanics, Differential equation of heat convection, Laminar flow heat transfer in circular pipe: constant heat flux and constant wall temperature, thermal entrance region, Turbulent flow heat transfer in circular pipe, pipes of other cross sections, Heat transfer in laminar flow and turbulent flow over a flat plate, Reynolds analogy, Flow across a cylinder and sphere, flow across banks of tubes, impinging jets • Natural Convection: Introduction, governing equations, Vertical plate – Pohlhausen solution, horizontal cylinder, horizontal plate, enclosed spaces Heat Exchangers: Types of heat exchangers, LMTD approach – parallel, counter-flow, multi-pass and cross flow heat exchanger, NTU approach: parallel, counter- flow, shell and tube, cross flow heat exchanger Condensation and Boiling: Dimensionless parameters, boiling modes, correlations, forced convection boiling, laminar film condensation on a vertical plate, turbulent film condensation • Mass Transfer: Analogy between heat and mass transfer, mass diffusion, Fick's law of diffusion, boundary conditions, steady mass diffusion through a wall, transient mass diffusion, mass convection, limitations of heat and mass transfer analogy.
4	**Texts/References**	1. Incropera FP and Dewitt DP, Fundamentals of Heat and Mass Transfer, 5th e, John Wiley & Sons, 2010. 2. Cengel YA, Heat and Mass Transfer - A Practical Approach, Third edition, McGraw-Hill, 2010. 3.Holman JP, Heat Transfer, McGraw-Hill, 1997.

1	**Title of the course** (L-T-P-C)	**Mechanics of Materials** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	**Module 1:** Basics: Fundamentals of mechanics of deformable solids. Concepts of stress and strain and their relationships. Axially loaded members - Normal stress and strain, Simple (direct) shear stress and strain, Hooke's law, Stresses on inclined planes under axial loading, thermal stresses and strains, statically indeterminate problems. Elastic strain energy under axial loads. **Module 2:** Torsion: torsion of circular cross-section shafts (Solid and hollow sections): Deformation field, Torsion formulae for stresses and angular deflection, Elastic strain energy under torsion, Closely-wound helical springs – stresses and deflections. **Module 3**: Bending: Euler – Bernoulli model: normal and shear stresses, deflections for symmetric bending. Statically indeterminate problems, Elastic strain energy under flexure. **Module 4:** Combined stresses: State of stress and strain at a point , transformation laws , Mohr's circle diagram for stress and principal stresses, thin walled structures : thin cylinders and spheres. Theories of failure: Maximum Normal-Stress theory, Maximum shear-stress theory and Maximum Distortional-energy theory. **Module 5:** Energy methods – Castigliano's theorem and its applications, fictitious-load method. Stability of structures – Buckling of idealized and elastic columns
4	**Texts/References**	**TEXTBOOKS:** 1) S.H Crandall, N.C Dahl and S.J Lardner, An Introduction to Mechanics of Solids, Tata McGraw Hill, Third Edition, 2012. 2) E.P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, 2nd edition, 2012. **REFERENCES:** 1. J. M. Gere and Goodno, Mechanics of Materials, 7th ed, Cengage Learning India, 2012. 2. J.P Den Hartog, Strength of Materials, Dover, 1949. 3. J.M Gere and S.P Timoshenko, Mechanics of Materials, CBS Publishers, 1986 4. R. C. Hibbeler, Mechanics of Materials, Pearson, 10th edition, 2016 . 5. S.P Timoshenko and D.H Young, Elements of strength of Materials, 5th ed, Affiliated East West Press, 1976. 6. F. P. Beer, E. R. Johnston Jr., John T. DeWolf , D. F. Mazurek, Mechanics of Materials, McGraw-Hill Education; 7th edition, 2014 7. M. Salvadori and R. Heller, Structure in Architecture, Prentice Hall Inc, 1963. 8. S.P Timoshenko, History of Strength of Materials, Dover, 1983. 9. M. H. Sadd, Elasticity: Theory, Applications, and Numerics, 1st ed, Elsevier India, 2006.

1	**Title of the course** (L-T-P-C)	**Electrochemistry** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Introduction to electrochemistry, electrode potentials, galvanic and electrolytic cells, electrode kinetics, dynamic electrochemistry, Liquid and solid electrolytes. Solid and liquid ionic conductors. The electrochemical double layer- theory and models. Overpotentials. Cyclic voltammetry, chronoamperometry, chronopotentiometry. Electrochemical syntheses of solid materials. Solid state electrochemistry. Intercalation processes. Industrial Electrochemical Processes: Fundamentals, Electrochemical Extraction of Metals, electrochemical synthesis of organic compounds.
4	**Texts/References**	1. L. I. Antrapov, Theoretical Electrochemistry, Mir Publishers, 1972. 2. J. J. O'M. Bockris and A. K. N. Reddy, Modern Electrochemistry, Vol. 1 and 2, 2nd edition, Plenum Press, 1998. 3. P. Atkins and J. de Paula, Atkins' Physical Chemistry, 8th edition, Oxford University Press, 2006. 4. Fundamentals of Electrochemistry, 2nd ed, Bagotsky, V.S., Hoboken: Wiley-Interscience 2006.

1	**Title of the course** (L-T-P-C)	**Introduction to Computational Chemistry (3-0-0-3)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Interpolation and Curve Fitting, Roots of Equations, Matrix Methods, Differential Equations, Numerical Integration, Integral Transforms, Ab initio methods, Density functional methods, Softwares for quantum mechanical calculations, Different forms of inputs for Ab initio calculations, Computation of single point energies, Geometry optimization, Electron densities and electrostatic potentials, Analysis of output for Gaussian programmes, Molecular frequencies, Modelling in solutions
4	**Texts/References**	1. I. R. Levine, *Quantum Chemistry*, Prentice Hall India (Ltd.), 1995. 2. A. Szabo and N. S. Ostlund, *Modern Quantum Chemistry*, McGraw- Hill, 1989. J. 3. GAMESS Program, Gaussian-11 Program

1	**Title of the course** (L-T-P-C)	**Introduction to Numerical Linear Algebra (3-1-0-4)**
2	**Pre-requisite courses(s)**	Calculus, MA 101 & Linear Algebra, MA 106
3	**Course content**	Floating point number system, Big O notation Matrix and vector norms, ill conditioned problems Solution of a system of linear equations, Gauss elimination, LU factorization, Cholesky method, Classical iterative methods: Jacobi and Gauss-Seidel Eigenvalue problems, Power method, QR method, Gershgorin theorem. Exposure to MATLAB
4	**Texts/References**	S. D. Conte and Carl de Boor, Elementary Numerical Analysis- An Algorithmic Approach (3rd Edition), McGraw-Hill, 1980

1	**Title of the course** (L-T-P-C)	**Differential Equations -I** **(3-1-0-4)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Exact equations, integrating factors and Bernoulli equations. Orthogonal trajectories. Lipschitz condition, Picard's theorem, examples on non-uniqueness. Linear differential equations generalities. Linear dependence and Wronskians. Dimensionality of space of solutions, Abel-Liouville formula. Linear ODE's with constant coefficients, the characteristic equations. Cauchy-Euler equations. Method of undetermined coefficients. Method of variation of parameters. Laplace transform generalities. Shifting theorems. Convolution theorem.
4	**Texts/References**	1. E. Kreyszig, Advanced engineering mathematics (10th Edition), John Wiley (1999) 2. W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005)

1	**Title of the course** (L-T-P-C)	**Biophysics** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	
3	**Course content**	● Diffusion and Brownian motion and Biological applications. ● Electrostatic interactions ● Chemical Potential and Chemical reactions ● Self-assembly, micelles, cell membranes ● Helix coil transition ● Stretching of macromolecules ● Protein folding ● Unzipping of DNA ● Machines in membranes ○ Electro-osmotic effects ○ Ion pumping ● Nerve Impulses ○ Action Potentials ○ Ion Channels ● Physical Techniques and related biology ○ X-ray diffraction, light and neutron scattering ○ Nuclear magnetic Resonance ○ Fluorescence ○ DNA Microarrays ○ Manipulation of bio-molecules using optical tweezers. ○ Tomography ○ Patch clamps
4	**Texts/References**	1. *Physical Biology of the Cell, Second Edition* by Rob Phillips, Jane Kondev, Julie Theriot, and Hernan Garcia (Garland Science, 2012). 2. *Biological Physics: Energy, Information, Life Student edition by Philip Nelson.* (Chiliagon Science)

1	**Title of the course** (L-T-P-C)	**Organic chemistry** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	**Reactive Intermediates**: An overview of the chemistry of carbenes, nitrenes, radicals, carbocations, carbanions and benzynes. Introduction to substitution, elimination, addition, oxidation, reduction, rearrangement types of reactions **Epoxidation named reactions**: Jacobsen and Sharpless. **Olefination named reactions**: Wittig, Julia, Wharton, Peterson, Tebbe. **Cross-Coupling named reactions**: Buchwald-Hartwig, Negishi, Sonogashira, Suzuki, Wurtz, Ullmann, McMurry, Heck, Stille. **Pericyclic reactions**: Diels-alder cycloaddition, Ene reaction, Cope rearrangement, Claisen rearrangement (Johnson, Ireland and Eschenmoser). **Organic chemistry in industry**: Pharmaceuticals, dye, and agrochemicals

4	**Texts/References**	1. Jerry March and Michael Smith, "Advanced Organic Chemistry", 7th Ed., Wiley, 2015. 2. F. A. Carey and R. J. Sundberg, "Advanced Organic Chemistry, Part A and B", 5th Ed., Springer, 2008. 3. J. Clayden, N. Greeves, and S. Warren, "Organic Chemistry", 2nd Ed., Oxford University Press, 2014. 4 W. Carruthers and I. Coldham, "Modern Methods of Organic Synthesis", 4th Ed., Cambridge University Press, 2015. 5. Laszlo Kurti and Barbara Czako, "Strategic applications of named reactions in organic synthesis", 1st Ed., Elsevier, 2005. 6. R. B. Grossman, "Art of writing reasonable organic reaction mechanisms", 2nd Ed., Springer, 2010. 7. P. Bruice, "Organic Chemistry" 7th Ed., Pearson, 2013. 8. Penny Chaloner, "Organic chemistry: A mechanistic approach, CRC Press; 1st edition, 2014

1	**Title of the course** (L-T-P-C)	**Reaction engineering (3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Kinetics Reaction rate, order, rate constant; Batch reactors Design + basics; Kinetic constants from batch reactor data; Ideal flow reactors Mass and Energy balances; Isothermal, adiabatic and non-isothermal operation; Catalysts, Catalytic rates, Reaction mechanisms; Internal/External transport in catalysts; Non-catalytic solid-gas reactions; Reactor design for ideal flow reactors; Yield and Selectivity; Concept of RTD; Segregation and Maximum Mixedness models

4	**Texts/References**	1. H.S.Fogler, Elements of Chemical Reaction Engineering, 2nd ed., Prentice Hall, New Jersey, 1992. 2. 2. O.Levenspiel, Chemical Reaction Engineering, 2nd ed., Wiley Eastern,1992 3. 3. J.M.Smith, Chemical Engineering Kinetics, 3rd ed., McGraw Hill, 1980.

1	**Title of the course** (L-T-P-C)	**Mass transfer** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	NIL
3	**Course content**	Principles of Mass transfer: Constitutive laws of diffusion; unsteady state diffusion; Convective mass transfer. Interphase mass transfer and mass transfer coefficients; Mass transfer theories/models; Equilibrium stages and transfer units: number and height of transfer units; stage efficiency. Gas absorption: plate and packed column design. Distillation: batch distillation, continuous fractionation, other types of distillation (e.g., azeotropic), solvent extraction, drying, cooling towers.
4	**Texts/References**	1. R.E.Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983. 2. E.D. Cussler, Di usion - Mass Transfer in Fluid Systems, Cambridge University Press, Cambridge 1984. 3. A. S. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980. 4. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, Prentice Hall, India, 1993.

1	**Title of the course** (L-T-P-C)	**Introduction to Electrical Systems and Electronics** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Exposure to Calculus
3	**Course content**	**From Physics to Electrical Engineering** (a) Lumped matter discipline (b) Batteries, resistors, current sources and basic laws (c) I-V characteristics and modeling physical systems **Basic Circuit Analysis Methods** (a) KCL and KVL, voltage and current dividers (b) Parallel and serial resistive circuits (c) More complicated circuits (d) Dependent sources, and the node method (e) Superposition principle (f) Thevenin and Norton method of solving linear circuits (g) Circuits involving diode. **Analysis of Non-linear Circuits** (a) Toy example of non-linear circuit and its analysis (b) Incremental analysis (c) Introduction to MOSFET Amplifiers (d) Large and small signal analysis of MOSFETs (e) MOSFET as a switch **Introduction to the Digital World** (a) Voltage level and static discipline (b) Boolean logic and combinational gates (c) MOSFET devices and the S Model (d) MOSFET as a switch; revisited (e) The SR model of MOSFETs (f) Non-linearities: A snapshot **Capacitors and Inductors** (a) Behavior of capacitors, inductors and its linearity (b) Basic RC and RLC circuits (c) Modeling MOSFET anomalies using capacitors (d) RLC circuit and its analysis (e) Sinusoidal steady state analysis (f) Introduction to passive filters **Operational Amplifier Abstraction** (a) Introduction to Operational Amplifier (b) Analysis of Operational amplifier circuits (c) Op-Amp as active filters (d) Introduction to active filter design **Transformers and Motors** (a) AC Power circuit analysis (b) Polyphase circuits (c) Introduction to transformers (d) Introduction to motors
4	**Texts/References**	1. Anant Agarwal and Jefferey H. Lang, “Foundations of Analog and Digital Electronics Circuits,” Morgan Kaufmann publishers, 2005 2. Wlilliam H. Hayt, Jr., Jack E. Kemmerly and Steven M. Durbin, “Engineering Circuit Analysis,” Tata McGraw-Hill 3. Theodore Wildi, “Electrical Machines, Drives and Power Systems,” Pearson, 6-th edition. 4. V. Del. Toro, “Electrical Engineering Fundamentals,” Pearson publications, 2nd edition.

Semester V						
S. No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	CL 301	Process Equipment Design and Economics	3	0	0	6
2	HS 201	Economics	3	0	0	6
3	CL 212	Chemical Engineering lab -II (Heat Transfer & Solid mechanics)	0	0	3	3
4	CL 213	Chemical Engineering Lab III (mass transfer and reaction engineering)	0	0	3	3
5		Programme elective-I	3	0	0	6
6	CH 306	Electrochemistry	3	0	0	3
7	CH 304	Introduction to computational chemistry	3	0	0	3
8		Programme elective-II	3	0	0	6
		Total Credits				36

1	**Title of the course** (L-T-P-C)	**Economics** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Basic economic problems. resource constraints and Welfare maximizations. Nature of Economics: Positive and normative economics; Micro and macroeconomics, Basic concepts in economics. The role of the State in economic activity; market and government failures; New Economic Policy in India. Theory of utility and consumer’s choice. Theories of demand, supply and market equilibrium. Theories of firm, production and costs. Market structures. Perfect and imperfect competition, oligopoly, monopoly. An overview of macroeconomics, measurement and determination of national income. Consumption, savings, and investments. Commercial and central banking. Relationship between money, output and prices. Inflation - causes, consequences and remedies. International trade, foreign exchange and balance payments, stabilization policies : Monetary, Fiscal and Exchange rate policies.
4	**Texts/References**	1. 1. P. A. Samuelson & W. D. Nordhaus, Economics, McGraw Hill, NY, 1995. 2. 2. A. Koutsoyiannis, Modern Microeconomics, Macmillan, 1975. R. Pindyck and D. L. Rubinfeld, Microeconomics, Macmillan publishing company, NY, 1989. 3. R. J. Gordon, Macroeconomics 4th edition, Little Brown and Co., Boston, 1987. 4. 4. William F. Shughart II, The Organization of Industry, Richard D. Irwin, Illinois, 1990. 5. 5. R.S. Pindyck and D.L. Rubinfeld. Microeconomics Th (7 Edition), Pearson Prentice Hall, New Jersey, 2009. 6. 6. R. Dornbusch, S. Fischer, and R. Startz. Macroeconomics (9th Edition), McGraw-Hill Inc. New York, 2004.

1	**Title of the course** (L-T-P-C)	**Reaction engineering** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Kinetics Reaction rate, order, rate constant; Batch reactors Design + basics; Kinetic constants from batch reactor data; Ideal flow reactors Mass and Energy balances; Isothermal, adiabatic and non-isothermal operation; Catalysts, Catalytic rates, Reaction mechanisms; Internal/External transport in catalysts; Non-catalytic solid-gas reactions; Reactor design for ideal flow reactors; Yield and Selectivity; Concept of RTD; Segregation and Maximum Mixedness models
4	**Texts/References**	1. H.S.Fogler, Elements of Chemical Reaction Engineering, 2nd ed., Prentice Hall, New Jersey, 1992. 2. 2. O.Levenspiel, Chemical Reaction Engineering, 2nd ed., Wiley Eastern,1992 3. 3. J.M.Smith, Chemical Engineering Kinetics, 3rd ed., McGraw Hill, 1980.

1	**Title of the course** (L-T-P-C)	**Chemical Engineering Lab III (mass transfer and reaction engineering) (0-0-3-3)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	*Mass transfer*: Experiments on hydrodynamics of a packed column, Differential distillation, drying, Cooling tower, gas liquid absorption *Reaction engineering*: Experiments on esterification kinetics, Batch reactive distillation, mi-cellar catalysis, homogeneous reaction, metal recovery from dilute solutions, reaction in CSTR, reaction in PFR
4	**Texts/References**	

1	**Title of the course** (L-T-P-C)	**Process Equipment Design and Economics (3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Mechanical design of process equipment: pressure vessels, tall columns, etc., process piping design; Materials and Fabrication Selection; Design Strategy and Optimum Equipment Design: Economic Design criteria; Cost and Asset Accounting; Cost Estimation; Interest and Investment Costs; Taxes and Insurance; Depreciation; Profitability, Alternative Investments and Replacement; Illustrative Case Study in Process Equipment Design and Costing of Equipment in each of the following categories: Material Transfer, Handling and Treatment Equipment Heat Transfer Equipment: Shell and tube heat exchangers (Kern and Bell-Delaware design methods), Plate heat exchangers, Evaporators Mass Transfer Equipment: Absorption/ Stripping columns (packed/tray), Multicomponent distallation colum (FenskeUnderwood-Gilliland correlations) Reactors: choice of reactors, non-isothermal reactors, reactor
4	**Texts/References**	5. R.E.Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983. 6. E.D. Cussler, Di usion - Mass Transfer in Fluid Systems, Cambridge University Press, Cambridge 1984. 7. A. S. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980. 8. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, Prentice Hall, India, 1993.

Name of Academic Unit : Chemistry

Level : UG

i	Title of the course	CH 306 Electrochemistry
ii	Credit Structure (L-T-P-C)	(3-0-0-3)
iii	Type of Course	Core course
vi	Pre-requisite(s), if any (For the students) – specify course number(s)	Fundamental concepts and applications of chemistry (CH101)
vii	Course Content*	Introduction to electrochemistry, electrode potentials, galvanic and electrolytic cells, electrode kinetics, dynamic electrochemistry, Liquid and solid electrolytes. Solid and liquid ionic conductors. The electrochemical double layer- theory and models. Overpotentials. Cyclic voltammetry, chronoamperometry, chronopotentiometry. Electrochemical syntheses of solid materials. Solid state electrochemistry. Intercalation processes. Industrial Electrochemical Processes: Fundamentals, Electrochemical Extraction of Metals, electrochemical synthesis of organic compounds.
Vii i	Texts/References	1. L. I. Antrapov, Theoretical Electrochemistry, Mir Publishers, 1972. 2. J. J. O'M. Bockris and A. K. N. Reddy, Modern Electrochemistry, Vol. 1 and 2, 2nd edition, Plenum Press, 1998. 3. P. Atkins and J. de Paula, Atkins' Physical Chemistry, 8th edition, Oxford University Press, 2006. 4. Fundamentals of Electrochemistry, 2nd ed,

		Bagotsky, V.S., Hoboken: Wiley-Interscience 2006.

Name of Academic Unit: Chemistry

Level: UG

i	Title of the course	CH 304 Introduction to computational chemistry
ii	Credit Structure (L-T- P-C)	(3-0-0-3)
iii	Type of Course	Core course
vi	Pre-requisite(s), if any (For the students) – specify course number(s)	Fundamental concepts and applications of chemistry (CH101)
vii	Course Content*	Interpolation and Curve Fitting, Roots of Equations, Matrix Methods, Differential Equations, Numerical Integration, Integral Transforms, Ab initio methods, Density functional methods, Softwares for quantum mechanical calculations, Different forms of inputs for Ab initio calculations, Computation of single point energies, Geometry optimization, Electron densities and electrostatic potentials, Analysis of output for Gaussian programmes, Molecular frequencies, Modelling in solutions
Vii i	Texts/References	1. I. R. Levine, Quantum Chemistry, Prentice Hall India (Ltd.), 1995. 2. A. Szabo and N. S. Ostlund, Modern Quantum Chemistry, McGraw- Hill, 1989. J. 3. GAMESS Program, Gaussian-11 Program

Semester VI						
S. No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	CH 402	Catalysis	3	0	0	3
2	CE 301	Environmental Studies	3	0	0	6
3	EE 303	Control systems and lab	2	0	2	6
4		Programme elective-III	3	0	0	6
5		Programme elective-IV	3	0	0	6
6		Scientific presentation	0	0	3	3
7	CL 401	Chemical reaction engineering-II	3	0	3	6
		Total Credits				36

1	**Title of the course** (L-T-P-C)	**Environmental studies** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Module A: Natural Resources, Ecosystems, Biodiversity and its conservation: Natural resources and ecosystems, Forest, grassland, desert and aquatic ecosystems, biodiversity at global, national and local levels, conservation of biodiversity Module B: Air Pollution Introduction to understanding air quality management, fundamental processes of meteorology, Air Pollutants – Gaseous and particulate, Criteria for pollutants, ambient and source standards, Aerosols: Characterisation of aerosols, size distributions, measurement methods; Transport behaviour: diffusion, sedimentation, inertia; Visibility; principles of particulate control systems. Module C: Water Treatment Discussion of water quality constituents and introduction to the design and operation of water and wastewater treatment processes. Module D: Solid Waste Management and Climate Change Different aspects of solid and hazardous waste management. Climate change and greenhouse gas emissions, technologies would reduce the greenhouse gas emissions. Climate change and its possible causes. Module E: Sociology/Environmentalism Description: Environmentalism in sociological tradition, Sustainability, North-South divide, Political economy approaches in environmental studies, Debates over environmental issues Module F: Economics Energy economics and financial markets, Market dynamics, Energy derivatives, Energy Efficiency; Sustainable Development: Concept, Measurement & Strategies, Interaction between Economic Development and the Environment Module G: Philosophy Environmental ethics, Deep ecology, Practical ecology, Religion and attitude towards environmental ethics, Ecofeminism and its evolution. Module H: Field work and project: visit to a local area to document environmental assets, case studies of a simple ecosystem and group discussions on current environmental issues.
4	**Texts/References**	1) Cunningham W.P. and Cunningham M.A. (2002), Principles of Environmental Science, Tata McGraw-Hill Publishing Company, New Delhi. 2) Dasgupta, P. and Maler, G. (eds.), (1997), The Environment and Emerging Development Issues, Vol. I, Oxford University Press, New Delhi. 3) Jackson, A.R.W. and Jackson, J.M. (1996), Environmental Sciences: The Environment and Human Impact, Longman Publishers. 4) Nathanson, J.A., (2002), Basic Environmental Technology, Prentice Hall of India, New Delhi. 5) Redclift, M. and Woodgate, G. (eds.), (1997), International Handbook of Environmental Sociology. 6)Srivastava, K.P. (2002), An Introduction to Environmental Study, Kalyani Publishers, Ludhiana. 7) Review articles from literature

1	**Title of the course** (L-T-P-C)	**Control Systems and Laboratory** **(2-0-2-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• **Basic concepts:** Notion of feedback, open- and closed-loop systems. • **Modeling and representations of control systems:** Transfer function models of for suitable mechanical, electrical, thermal and pneumatic systems, Ordinary differential equations, Transfer functions, Block diagrams, Signal flow graphs, State-space representations. • **Performance and stability:** Time-domain analysis, Second-order systems, Characteristic-equation and roots, Routh-Hurwitz criteria. • **Basic modes of feedback control:** Proportional, Integral, Derivative. • **Root locus** method of design. • **Frequency-domain techniques:** Root-locus methods, Frequency responses, Bode-plots, Gain-margin and phase-margin, Nyquist plots. • **Compensator design:** Proportional, PI and PID controllers, Lead-lag compensators. • **State-space concepts:** Controllability, Observability, pole placement result, Minimal representations. Laboratory involves set of experiments following the theory component covered in the class
4	**Texts/References**	1. Norman Nise, Control System Engineering, Wiley, 6th Edition, 2011 2. K. Ogata, Modern Control Engineering, Pearson, 5th edition, 2010. 3. Gene franklin et. al., “Feedback Control of Dynamic Systems”, 7th Edition, Pearson 4. B. Kuo, Automatic Control System, Wiley, 9th Edition, 2014

1	**Title of the course** (L-T-P-C)	**Chemical Reaction Engineering-II (3-0-3-6)**
2	**Pre-requisite courses(s)**	Reaction Engineering
3	**Course content**	Multiphase reactors (Gas-Liquid; Liquid-Liquid); Yield, Selectivity, Reactor Design for Multiple Reactions; Models of Industrial Reactors: Pressure Drop considerations, Heat management, non-isothermal reactors, Steady State multiplicity; Residence Time Distribution: Theory; Evaluation from Tracer Experiments; Non-Ideal Reactor Modelling: Use of RTD; Zero, One and Two Parameter Models; Compartment Modelling; Applications: Polymerisation; Combustion; Biochemical Reactions; Multi- functional Reactors; Stochastic approaches to kinetics.

4	**Texts/References**	1. H.S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall, 2nd ed., New Jersey, 1992. 2. O. Levenspiel, Chemical Reaction Engineering, Wiley Eastern, 2nd ed., 1972. 3. J.M. Smith, Chemical Engineering Kinetics, 3rd ed., McGraw Hill, 1980.

1	**Title of the course** (L-T-P-C)	**Catalysis** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Fundamentals of catalysis, including kinetics and mechanistic models. Heterogeneous and homogenous catalysis. The fundamentals of electrocatalysis and the effects of coupling proton and electron transfer for catalytic redox reactions. Surface properties and function in heterogeneous catalysis. Structure, bonding and reactivity of coordination compounds and metalloorganic complexes based on transition metals. MO theory and 18-electron rule. Ligand substitution, alkene isomerization hydroboration, hydrocyanation, hydrogenation of olefins, Wilkinson's catalyst hydroformylation of olefins, Wacker-Schmidt synthesis, Monsanto acetic acid process, Fischer-Tropsch process.
4	**Texts/References**	1. J. F. Hartwig, Organotransition Metal Chemistry: From Bonding to Catalysis, 1stEd, University Science Books, 2010. 2. Vishwanathan, S. Sivasanker, A.V. Ramaswamy, Catalysis – Principles & Applications

Semester VII						
S. No	Course Code	Course Name	L	T	P	C
1		HSS Elective	3	0	0	6
2		Institute Elective-I	3	0	0	6
3		Institute Elective-II	3	0	0	6
4		Programme elective-V/ BTP-I	3	0	0	6
5		Programme elective-VI	3	0	0	6
6	CL 402	Advanced Transport phenomena	3	0	0	6
		Total Credits				36

1	**Title of the course** (L-T-P-C)	**Advanced Transport phenomena** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Reaction Engineering
3	**Course content**	Introduction: Review of Transport Equations, Scaling and Ordering analysis, Asymptotic solutions. Exact solutions: Pul-satile flow in circular tube, Creeping flows and streamfunction solutions. Motion of deformable and slender bodies: Condi-tions at an deformable interface, Creeping flow past a drop, Marangoni E ects, Flows past Sphere and Oblate Solid bodies, Slender-Body Theory. Asymptotic Approximations for simple flows: Pulsatile flow limiting cases, Motion of fluid through curved tube, Bubble growth in Quiescent fluid. Thin films and Lubrication: Eccentric Couette cylinder, Lubrication theory, Slider block, Cylinder and Plane. Convective Heat and Mass transfer: Heat transfer from sphere ($Pe << 1$) in uniform and shear flow, Low Re expansion for $Pe << 1$, $Pe >> 1$ for low Re, Mass transfer from a Drop Laminar Boundary layer Theory: Review of Boundary Layer Equations and Solution, Boundary layer separation, Approximate method to estimate shear stresses, Spherical bubble, Limiting cases of Thermal boundary layers. Natural convection: Boussinesq Equations, Combined forced and free convection, The Raleigh-Benard Problem.
4	**Texts/References**	L. G. Leal, Laminar Flow and Convective Transport Processes, Butterworth-Heinemann, 1992.

Semester VIII						
S. No	Course Code	Course Name	L	T	P	C
1		Institute Elective-III	3	0	0	6
2		Institute Elective-IV/ HSS elective	3	0	0	6
3		Programme elective-VII/BTP -II	3	0	0	6
4		Programme elective-VIII	3	0	0	6
5		Programme elective-IX	3	0	0	6
		Total Credits				30
	Total Cumulative Credits after 4th Year					291