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 Course	Full
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/	No

	other academic unit(s) which is/ are equivalent to this course? If so, please give details.	
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 (1st Half)	3	1	0	4
2	MA 103	Differential Equations - I (2nd Half)	3	1	0	4
3	CS 201	Data Structures and Algorithms	3	0	0	6
4	CS 211	Data Structures and Algorithms Laboratory	0	0	3	3
5	PH 102	Electricity and Magnetism	2	1	0	6
6	BB 201	Biomolecules	2	1	0	6
7	CH 203	States of Matter (2nd Half)	3	0	0	3
8	CH 201	Organic Chemistry (1st Half)	3	0	0	3
9	CH 113	Hands On Science Laboratory - II	0	0	3	3
10	NO 105/ NO 107	National Sports Organization (NSO)/National Service Scheme (NSS)	0	0	2	2
		Total Credits				40

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)	**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)	**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)	**Electricity and Magnetism** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	] Review of vector calculus: Spherical polar and cylindrical coordinates; gradient, divergence and curl;] Divergence and Stokes` theorems; ] Divergence and curl of electric field, Electric potential, properties of conductors; ] Poisson's and Laplace's equations, uniqueness theorems, boundary value problems, separation of variables, method of images, multipoles; ] Polarization and bound charges, Gauss` law in the presence of dielectrics, Electric displacement D and boundary conditions, linear dielectrics;] Divergence and curl of magnetic field, Vector potential and its applications;] Magnetization, bound currents, Ampere`s law in magnetic materials, Magnetic field H, boundary conditions, classification of magnetic materials;] Faraday's law in integral and differential forms, Motional emf, Energy in magnetic fields, Displacement current, Maxwell's equations,] Electromagnetic (EM) waves in vacuum and media, Energy and momentum of EM waves, Poynting`s theorem; Reflection and transmission of EM waves across linear media.
4	**Texts/References**	(1) Introduction to Electrodynamics (4th ed.), David J. Griffiths, Prentice Hall, 2015. (2) Classical Electromagnetism, J. Franklin, Pearson Education, 2005.

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)	**States of matter** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	The Gaseous State: Gas laws, Equation of state, Concept of temperature, pressure, partial pressure, density, Mole concept. Kinetic Theory of Gases: Maxwells distribution of molecular velocities, Collisions theory. Viscosity of gases. Energy distribution function, Phase rule and equilibria. Real Gases: Deviations from ideal behaviour, Compressibility factors, van der Waals and Virial equation, Reduced equation of state, Law of corresponding states, Critical phenomena, Intermolecular forces. The solid and liquid states and their properties.
4	**Texts/References**	1. K. L. Kapoor, A Textbook of Physical Chemistry, States of Matter and Ions In Solution (SI Units) - Vol. 1 | 6th Edition 2. P. Atkins, Julio de Paula, J. Keeler, Atkins' Physical Chemistry: International Eleventh Edition

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

Semester III						
S.No	Course Code	Course Name	L	T	P	C
1	HS 201	Economics	3	0	0	6
2	BB 301	Basics of Cell Biology and Genetics	3	0	0	6
3	CH 204	Physical Organic and Bioorganic Chemistry (1st Half)	3	0	0	3
4	CH 202	Inorganic Chemistry (2nd Half)	3	0	0	3
5	MA 209	Introduction to Probability Theory	3	1	0	8
6	PH 103	Waves, Oscillations & Optics	2	1	0	6
7		Mathematics Laboratory	0	0	3	3
		Total Credits				35

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. P. A. Samuelson & W. D. Nordhaus, Economics, McGraw Hill, NY, 1995. . 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. William F. Shughart II, The Organization of Industry, Richard D. Irwin, Illinois, 1990. . 5. R.S. Pindyck and D.L. Rubinfeld. Microeconomics Th (7 Edition), Pearson Prentice Hall, New Jersey, 2009. . 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)	**Basics of Cell Biology and Genetics** **(2-1-0-6)**
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)	**Physical Organic and Bioorganic Chemistry** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Symmetry-adapted orbitals, pericyclic reactions and frontier molecular orbital approach (FMO), Mixing rules and build-up approach to molecules, Thermodynamic and kinetic control of reactions, linear free energy relationships, Hammond's postulate, Curtin-Hammett principle, substituent and reaction constants, isotope effects, Stereoelectronic effects, reaction mechanism models 1. Organic chemistry of biological macromolecules (proteins, carbohydrates, nucleic acids, fats etc.) and chemistry of biological pathways, chemical biology and role of chemistry in understanding life processes and medicine
4	**Texts/References**	1. E. V. Anslyn and D. A. Dougherty, *Modern Organic Chemistry*, University Science, 2005. 2. Carey, F. A., Sundberg, R. J. *Advanced Organic Chemistry*, *Part A and B*, Springer, 2007. 3. T. H. Lowry and K. H. Richardson, *Mechanisms and Theory in Organic Chemistry*, Harper and Row, 1976. 4. Isaacs, N. S. *Physical Organic Chemistry*, Prentice Hall, 1996. 5. Deslongchamps, P. *Stereoelectronic Effects in Organic Chemistry*, Elsevier Science, 1983. 6. B. G. Davis & A.J. Farbanks, Carbohydrate Chemistry, 1st Edition, Oxford University Press, 2002 7. S. Doonan, Nucleic Acids, 1st Edition, RSC Publishing House, London, 2000 8. A. Lehninger, D. L. Nelson, Cox, M. M. Principles of Biochemistry, 5th Edition, W.H Freeman, 2008

1	**Title of the course** (L-T-P-C)	**Inorganic Chemistry** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Concepts and principles of non-transition metal chemistry: An overview of bonding models (ionic & covalent) in inorganic chemistry , Chemical forces, Bent's rule, Application of molecular orbital theory to triatomic linear molecules (localized and delocalized orbitals), Walsh diagrams. Main group Chemistry: General characteristics of s- and p-block elements, comparative study of second short period elements (B to F) with heavy congeners (Al to Cl). Electron deficient molecules and hypervalency.
4	**Texts/References**	1. Atkins, P., et al., Shriver and Atkins Inorganic Chemistry, 4th Ed., Oxford University Press, 2006. 2. Lee, J. D., Concise Inorganic Chemistry, 5th Ed., Blackwell Publishing, 2006. 3. Cotton, F. A., Wilkinson, G., Gaus, P. L., Basic Inorganic Chemistry, 3rd Ed., John Wiley and Sons Press, 1995. 4. Douglas, B., McDaniel, D., Alexander, J., Concepts and Models of Inorganic Chemistry, 3rd Ed. Wiley India (P.) Ltd., India, 2010.

1	**Title of the course** (L-T-P-C)	**Introduction to probability theory** **(3-1-0-8)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	Combinatorial probability and urn models, Independence of events, Conditional probabilities, Random variables, Distributions, Expectation, Variance and moments, probability generating functions and moment generating functions, Standard discrete distributions (uniform, binomial, Poisson, geometric, hypergeometric), Independence of random variables, Joint and conditional discrete distributions. Univariate densities and distributions, standard univariate densities (normal, exponential, gamma, beta, chi-square, Cauchy). Expectation and moments of continuous random variables. Transformations of univariate random variables. Tchebychev's inequality. Modes of convergence. Law of large numbers. Central limit theorem.
4	**Texts/References**	• 1. K. L. Chung and F. AitSahlia, Elementary Probability Theory., 4th Edition, Springer Verlag, 2003 • R. Ash : Basic Probability Theory, Dover publication, • W. Feller : Introduction to Probability Theory and its Applications, Volume 1, Wiley-India Edition • W. Feller : Introduction to Probability Theory and its Applications, Volume 2, Wiley India Edition

Semester IV						
S.No	Course Code	Course Name	L	T	P	C
1	MA 220	Real Analysis	2	1	0	6
2	MA 221	Group Theory	2	1	0	6
3	MA 202	Advanced Linear Algebra	2	1	0	6
4		Program Elective-I				6
5		Program Elective-II				6
		Total Credits				30

1	**Title of the course** (L-T-P-C)	**Real Analysis** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Calculus and Linear Algebra or Instructor's consent
3	**Course content**	Review of basic concepts of real numbers: Archimedean property, Completeness. Metric spaces, compactness, connectedness, (with emphasis on Rn). Continuity and uniform continuity. Monotonic functions, Functions of bounded variation; Absolutely continuous functions. Derivatives of functions and Taylor's theorem. Riemann integral and its properties, characterization of Riemann integrable functions. Improper integrals, Gamma functions. Sequences and series of functions, uniform convergence and its relation to continuity, differentiation and integration. Fourier series, pointwise convergence, Fejer's theorem, Weierstrass approximation theorem.
4	**Texts/References**	W. Rudin, Principles of Mathematical Analysis, 3rd Edition, McGraw-Hill, 1983 T. Apostol, Mathematical Analysis, 2nd Edition, Narosa, 2002. S. Abbott, Understanding Analysis, 2nd Edintion, Springer Verlag New York, 2015 S. R. Ghorpade and B. V. Limaye, A course in Calculus and Real Analysis, 2nd Edition, Springer international publishing, 2018

1	**Title of the course** (L-T-P-C)	**Group Theory** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	NIL
3	**Course content**	Symmetries of plane figures, translations, rotations and reflections in the Euclidean plane, composing symmetries, inverse of a symmetry, Cayley tables Definition of group, basic properties, examples, Homomorphisms, Isomorphisms, subgroups, subgroup generated by a set, Cyclic groups, subgroups of cyclic groups, Review of Equivalence relations, Cosets, Lagrange's theorem, Normal subgroup, Quotient Group, Examples, Isomorphism theorems, Automorphisms Group actions, conjugacy classes, orbits and stabilizers, faithful and transitive actions, centralizer, normalizer, Cayley's theorem. Conjugation, Class equation, Cauchy's theorem, Applications to p-groups, Conjugacy in S 5 Sylow theorems, Simplicity of A_n and other applications Direct products, Structure of Finite abelian groups Semi-Direct products, Classification of groups of small order Normal series, Composition series, Solvable groups, Jordan- Holder theorem, Insolvability of S_5 Lower and upper central series, Nilpotent groups, Basic commutator identities, Decomposition theorem of finite nilpotent groups (if time permits) Three dimensional symmetries: platonic solids and their dual, symmetries of a tetrahedron, symmetries of a cube and octahedron, symmetries of icosahedron and dodecahedron, classification of finite subgroups of SO(3) (if time permits).
4	**Texts/References**	M. Artin, Algebra, Prentice Hall of India, 1994. D. S. Dummit and R. M. Foote, Abstract Algebra, 2nd Edition, John Wiley, 2002. J. A. Gallian, Contemporary Abstract Algebra, 4th Edition, Narosa, 1999. I.N. Herstein, Topics in Algebra, Wiley, 2nd Edition, 1975. K. D. Joshi, Foundations of Discrete Mathematics, Wiley Eastern, 1989. S. Lang, Undergraduate Algebra, 2nd Edition, Springer, 2001. S. Lang, Algebra, 3rd Edition, Springer (India), 2004.

1	**Title of the course** (L-T-P-C)	**Advanced Linear Algebra** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	MA 102 or Instructor's consent
3	**Course content**	Review of Linear algebra from MA 102: Systems of linear equations, matrices, rank, Gaussian elimination, Linear transformations, representation of linear transformations by matrices, rank-nullity theorem, duality and transpose, Determinants, Laplace expansions, cofactors, adjoint, Cramer's Rule. Abstract vector spaces over fields, subspaces, bases and dimension. Eigenvalues and eigenvectors, characteristic polynomials, minimal polynomials, CayleyHamilton Theorem, triangulation, diagonalization, rational canonical form, Jordan canonical form. Inner product spaces, Gram-Schmidt orthonormalization, orthogonal projections, linear functionals and adjoints, Hermitian, self-adjoint, unitary and normal operators, Spectral Theorem for normal operators Bilinear forms, symmetric and skew-symmetric bilinear forms, real quadratic forms, Sylvester's law of inertia, positive definiteness.
4	**Texts/References**	H. Anton, Elementary linear algebra and applications, 8th edition, John Wiley, 1995. M. Artin, Algebra, Prentice Hall of India, 1994. S. Kumaresan, Linear algebra - A Geometric Approach, Prentice Hall of India, 2000. K. Hoffman and R. Kunze, Linear Algebra, Pearson Education (India), 2003. S. Lang, Linear Algebra, Undergraduate Texts in Mathematics, Springer-Verlag, New York, 1989. G. Strang, Linear algebra and its applications, 4th edition, Thomson, 2006.

Semester V						
S.No	Course Code	Course Name	L	T	P	C
1	MA 307	Rings and Modules	2	1	0	6
2	MA 308	Introduction to Complex Analysis	2	1	0	6
3	MA 309	General Topology	2	1	0	6
4	CS 403	Graph Theory and Combinatorics	3	0	0	6
5		Program Elective-II				6
		Total Credits				30

1	**Title of the course** (L-T-P-C)	**Rings and Modules** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Group Theory
3	**Course content**	Definition of rings, Homomorphisms, basic examples (Polynomial ring, Matrix ring, Group ring), Integral domain, field, Field of fractions of an integral domain Ideals, Prime and Maximal ideals, Quotient Rings, Isomorphism theorems, Chinese Remainder theorem, Applications Principal ideal domains, Irreducible elements, Unique factorization domains, Euclidean domains, examples Polynomial rings, ideals in polynomial rings, Polynomial rings over fields, Gauss' Lemma, Polynomial rings over UFDs, Irreducibility criteria, Hilbert's basis theorem Definition of modules, submodules, The group of homomorphisms, Quotient modules, Isomorphism theorems, Direct sums, Generating set, Noetherian modules, free modules, Simple modules, vector spaces Free modules over a PID, Finitely generated modules over PIDs, Applications to finitely generated abelian groups and Rational and Jordan canonical forms (if time permits) Closed subsets of affine space, coordinate rings, correspondence between ideals and closed subsets, affine varieties, Hilbert's nullstellensatz
4	**Texts/References**	M. Artin, Algebra, Prentice Hall of India, 1994. M. F. Atiyah and I. G. Macdonald, Introduction to Commutative Algebra, Addison Wesley, 1969. D. S. Dummit and R. M. Foote, Abstract Algebra, 2nd Edition, John Wiley, 2002. N. Jacobson, Basic Algebra I and II, 2nd Edition, W. H. Freeman, 1985 and 1989. S. Lang, Algebra, 3rd Edition, Springer (India), 2004. O. Zariski and P. Samuel, Commutative Algebra, Vol. I, Springer, 1975.

1	**Title of the course** (L-T-P-C)	**Introduction to Complex Analysis** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Real analysis and calculus OR Instructor's consent
3	**Course content**	Definition and properties of analytic functions. Cauchy- Riemann equations, harmonic functions. Power series and their properties. Elementary functions. Cauchy's theorem and its applications. Taylor series and Laurent expansions. Evaluation of improper integrals. Conformal mappings. Inversion of Laplace transforms. Isolated singularities and residues.Residues and the Cauchy residue formula. Zeroes and poles, Maximum Modulus Principle, Argument Principle, Rouche's theorem.
4	**Texts/References**	E. Kreyszig, Advanced engineering mathematics (10th Edition), John Wiley (1999) R. V. R. V. Churchill and J. W. Brown, Complex variables and applications (7th Edition), McGraw-Hill (2003) Theodore Gamelin, Complex Analysis – Springer Undergraduate texts in Mathematics (2003) J.B Conway, Functions of one complex variable, Springer, 7th printing 1995 edition.

1	**Title of the course** (L-T-P-C)	**General Topology** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Calculus, Linear Algebra, Real Analysis and Elements of Metric Space Theory or Instructor's consent
3	**Course content**	Topological Spaces: open sets, closed sets, neighbourhoods, bases, sub bases, limit points, closures, interiors, continuous functions, homeomorphisms. Examples of topological spaces: subspace topology, product topology, metric topology, order topology. Quotient Topology: Construction of cylinder, cone, Moebius band, torus, etc. Connectedness and Compactness: Connected spaces, Connected subspaces of the real line, Components and local connectedness, Compact spaces, Heine-Borel Theorem, Local - compactness. Separation Axioms: Hausdorff spaces, Regularity, Complete Regularity, Normality, Urysohn Lemma, Tychonoff embedding and Urysohn Metrization Theorem, Tietze Extension Theorem. Tychnoff Theorem, One-point Compactification. Complete metric spaces and function spaces, Characterization of compact metric spaces, equicontinuity, Ascoli-Arzela Theorem, Baire Category Theorem. Applications: space filling curve, nowhere differentiable continuous function.
4	**Texts/References**	J. R. Munkres, Topology, 2nd Edition, Pearson Education (India), 2001. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 1963. M. A. Armstrong, Basic Topology, Springer (India), 2004

1	**Title of the course** (L-T-P-C)	**Graph Theory and Combinatorics** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Discrete Structures
3	**Course content**	Fundamentals of graph theory. Topics include: connectivity, planarity, perfect graphs, coloring, matchings and extremal problems. Basic concepts in combinatorics. Topics include: counting techniques, inclusion-exclusion principles, permutations, combinations and pigeon- hole principle.
4	**Texts/References**	"An Introduction to Quantum Field Theory", Michael Peskin and Daniel Schroeder (Addison Wesley) "Introduction to Quantum Field Theory", A. Zee "Quantum Field Theory", Lewis H. Ryder "Quantum Field Theory and Critical Phenomena", by Jean Zinn-Justin. "Quantum field Theory for the Gifted Amateur", T. Lancaster and Stephen J. Blundell NPTEL lectures in Quantum Field Theory (https://nptel.ac.in/courses/115106065/)

Semester VI						
S.No	Course Code	Course Name	L	T	P	C
1	CE 301	Environmental Studies	3	0	0	6
	MA 305	Ordinary Differential Equations	2	1	0	6
	MA 901	Measure Theory	3	1	0	8
		Program Elective-III				6
		HSS Elective-I	3	0	0	6
		Total Credits				30

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)	**Ordinary Differential Equations** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Calculus 1 and 2, Linear Algebra, DE 1 or Instructor's consent
3	**Course content**	Review of solution methods for first order as well as second order equations, Power Series methods with properties of Bessel functions and Legendre polynomials. Existence and Uniqueness of Initial Value Problems: Picard's and Peano's Theorems, Gronwall's inequality, continuation of solutions and maximal interval of existence, continuous dependence. Higher Order Linear Equations and linear Systems: fundamental solutions, Wronskian, variation of constants, matrix exponential solution, behaviour of solutions.Two Dimensional Autonomous Systems and Phase Space Analysis: critical points, proper and improper nodes, spiral points and saddle points.Asymptotic Behavior: stability (linearized stability and Lyapunov methods). Boundary Value Problems for Second Order Equations: Green's function, Sturm comparison theorems and oscillations, eigenvalue problems.
4	**Texts/References**	M. Hirsch, S. Smale and R. Deveney, Differential Equations, Dynamical Systems and Introduction to Chaos, Academic Press, 2004 L. Perko, Differential Equations and Dynamical Systems, Texts in Applied Mathematics, Vol. 7, 2nd Edition, Springer Verlag, New York, 1998. M. Rama Mohana Rao, Ordinary Differential Equations: Theory and Applications. Affiliated East-West Press Pvt. Ltd., New Delhi, 1980. D. A. Sanchez, Ordinary Differential Equations and Stability Theory: An Introduction, Dover Publ. Inc., New York, 1968.

1	**Title of the course** (L-T-P-C)	**Measure Theory** **(3-1-0-8)**
2	**Pre-requisite courses(s)**	Real analysis
3	**Course content**	Construction of Lebesgue measure on Real line, Introduction to abstract measure theory, Measurable functions, Caratheodory's Extension Theorem, MCT, Fatou's Lemma, DCT, Product space, Product measure, Fubini's Theorem, Definition of signed measures, Positive and negative sets. Hahn-Jordan Decomposition. Absolute continuity of two σ- finite measures. Radon-Nikodyme Theorem and Lebesgue Decomposition.
4	**Texts/References**	H. L. Royden; Real analysis. Third edition. Macmillan Publishing Company, New York, 1988. W. Rudin; Real and complex analysis. Third edition. McGraw- Hill Book Co., New York, 1987. S. Athreya and V.S. sunder; Measure & probability. CRC Press, Boca Raton, FL, 2018. K.R. Parthasarathy; Introduction to probability and measure, Hindustan Book Agency, 2005.

Semester VII						
S.No	Course Code	Course Name	L	T	P	C
1	MA 404	Numerical Analysis	2	1	0	6
2		Program Elective-IV				6
3		Program Elective-V				3
4		Institute Elective – I	2	1	0	6
5		HSS Elective-II	3	0	0	6
		Total Credits				27

1	**Title of the course** (L-T-P-C)	**Numerical Analysis** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Calculus 1 and 2, Linear Algebra, DE 1, Ordinary Differential Equations or Instructor's consent
3	**Course content**	Linear Systems of Equation, LU decomposition, Classical iterative techniques and ill conditioned systems Matrix eigenvalue problems, Power iteration, Jacobi and QR methods Approximation theory, interpolation (Lagrange, Hermite and piecewise interpolation) and best approximations in inner product spaces Nonlinear Equations and their iterative solution Numerical Integration, interpolatory quadratures, Gauss quadrature, quadrature of periodic functions and Romberg integration Finite Difference methods, convergence, stability and consistency, Lax equivalence theorem
4	**Texts/References**	Rainer Kress, Numerical Analysis, 1st Edition, Springer-Verlag New York, 1998 J. Stoer and R. Bulirsch, Introduction to Numerical Analysis, 3rd Edition, Springer-Verlag New York, 2002 K. Atkinson and Weimin Han, Theoretical Numerical Analysis, A functional Analysis framework, 3rd Edition, Springer-Verlag New York, 2001 P. Deuflhard and A Hohmann, Numerical Analysis in modern scientific computing, An introduction, 2nd Edition, Springer-Verlag New York, 2003

Semester VIII						
S.No	Course Code	Course Name	L	T	P	C
1		Program Elective-VI	2	1	0	6
2		Institute Elective – II	2	1	0	6
3		Institute Elective – III				6
4		Institute Elective – IV				6
5		Institute Elective – v				6
		Total Credits				30

Semester IX			
1		Independent Project	30
Semester X			
2		Independent Project	30
		Total Credits	60