Chemistry Department					
S.No	**Course code**		**Name of Course**	**L-T-P-C**	**Proposed Level (UG/PG)**
1	CH 102	CH101T	Fundamental Concepts &Applications of Chemistry	3-0-0-6	UG
2	CH 111		Chemistry Lab	0-0-3-3	UG
3	PH 113	CH101L	Hands on Science Laboratory	0-0-3-3	UG
4	CH 201	CH201T	Organic chemistry	3-0-0-3	UG
5	CH 202	CH202T	Inorganic Chemistry.	3-0-0-3	UG
6	CH 203	CH203T	States of matter	3-0-0-3	UG
7	CH 204	CH204T	Physical Organic and Bioorganic Chemistry	3-0-0-3	UG
8	CH 301		Environmental studies	3-0-0-6	UG
9	CH 302	CH301T	Sustainable energy and energy materials	3-0-0-6	UG
10	CH 303	CH302T	Bioenergy and Biofuels	3-0-0-6	UG
11	CH 304	CH303T	Introduction to computational chemistry	3-0-0-3	UG
12	CH 305	CH304T	Introduction to Sophisticated characterization Techniques	2-0-2-6	UG
13	CH 306	CH305T	Electrochemistry		UG
14	CH 307	CH605T	Instrumental methods for structure determination	2-1-0-6	UG
15	CH 308	CH307T	Non-transition and transitional metal chemistry	2-1-0-6	UG
16	CH 309		Chemical Bonding and Symmetry	2-1-0-6	UG
17	CH 310	CH501T	Organic reactions and reagents	2-1-0-6	UG
18	CH 311	CH301L	Chemistry laboratory-I	0-0-3-3	UG
19	CH 312	CH401L	Chemistry laboratory-II	0-0-3-3	UG
20	CH 313	CH402L	Chemistry laboratory-III	0-0-3-3	UG
21	CH 314	CH501L	Chemistry laboratory-IV	0-0-3-3	UG
22	CH 320	CH402T	Molecular Energetics and Dynamics	2-1-0-6	UG
23	CH 321	CH606T	Concepts in organic synthesis	2-1-0-6	UG
24	CH 322	CH503T	Molecular spectroscopy	2-1-0-6	UG
25	CH 323	CH306T	Coordination and organometallic chemistry	3-0-0-6	UG
26	CH 401	CH504T	Statistical Mechanics	2-1-0-6	UG
27	CH 402	CH403T	Catalysis	3-0-0-3	UG
28	CH 403	CH404T	Quantum Field Theory	2-1-0-6	UG
29	CH 404	CH405T	Chemical biology and medicinal chemistry	3-0-0-6	UG
30	CH 405	CH406T	Our Health and Medicine	3-0-0-6	UG
31	CH 406	CH407T	Material science and polymer chemistry	3-0-0-6	UG

32	CH 407	CH408T	Bioinorganic and biophysical chemistry	3-0-0-3	UG
33	CH 408	CH505T	Supramolecular chemistry	3-0-0-3	UG
34	CH 409	CH506T	Solid State Chemistry and its Applications	3-0-0-6	UG
35	CH 410	CH507T	X-ray crystallography and applications	3-0-0-6	UG
36	CH 420	CH704T	Seminar	2-0-4-4	UG
37	CH 421	CH508T	Computational Chemistry	3-0-0-6	UG
38	CH 422	CH509T	Pericyclic reactions and photochemistry	3-0-0-3	UG
39	CH 423	CH409T	Bioorganic chemistry and Chemical Biology	3-0-0-3	UG
40	CH 424	CH510T	Heterocyclic chemistry and natural products	3-0-0-3	UG
41	CH 425	CH601T	Advanced organic synthesis	3-0-0-6	UG
42	CH 426	CH602T	Advanced Inorganic Chemistry	3-0-0-6	UG
43	CH 427	CH410T	Organic chemistry of enzymes and biosynthesis	3-0-0-3	UG
44	CH 428	CH517T	Quantum Chemistry	3-0-0-6	UG
45	CH 429	CH504T	Statistical Mechanics	3-0-0-6	UG
46	CH 430	CH412T	Organometallics and organometallic reagents	3-0-0-6	UG
47	CH 901	CH603T	Coordination chemistry, Organometallics and organometallic reagents	3-0-0-6	PG
48	CH 902	CH604T	Organic spectroscopy	3-0-0-6	PG
49	CH 903	CH701T	Interpretative NMR spectroscopy and mass spectrometry	3-0-0-6	PG
50	CH 904	CH702T	Advanced computational chemistry	3-0-0-6	PG
51	CH 905		Analysis of optical and electronic properties **of π-conjugated compounds and pertinent applications**	3-0-0-6	PG
52	CH 910	CH704T	Seminar	2-0-0-4	PG
53	CH 911	CH705T	Bioorganic chemistry and Chemical Biology	3-0-0-6	PG
54	CH 913	CH706T	Fundamentals and Applications of Organic Photochemistry	3-0-0-6	PG
55	CH 915	CH504T	Molecular spectroscopy	3-0-0-6	PG
56	CH 916	CH801T	Optical and electronic properties of π-conjugated	3-0-0-6	PG
57	CH 917	CH802T	Organic reactions and mechanisms (3-0-0-6)	3-0-0-6	PG
58	CH 918	CH803T	Topics in Chemistry	3-1-0-6	PG
59	CH 921	CH707T	Green Chemistry	3-0-0-6	PG
60	CH 919	CH708T	Advanced Quantum Chemistry	3-0-0-6	PG
61	CH 920	CH709T	Inorganic Chemistry in Biology	3-0-0-6	PG
62		CH513T	Concepts and Mechanisms in Organic Chemistry	3-0-0-6	PG
63			Chemistry of carbohydrates	3-0-0-6	PG

64		CH512T	Transition Metals and Coordination Chemistry	3-0-0-6	PG
65		CH511T	Main group chemistry	3-0-0-6	PG
66		CH301L	Chemistry laboratory-I	0-0-3-3	PG
67		CH401L	Chemistry Laboratory II	0-0-3-3	PG
68		CH402L	Chemistry laboratory-III	0-0-3-3	PG
69		CH501L	Chemistry laboratory-IV	0-0-3-3	PG
70		CH607T	Organometallic Chemistry and Catalysis	3-0-0-6	PG
71			Organic chemistry	3-0-0-6	PG
72			Bioinorganic and Bioorganic chemistry	3-0-0-6	PG
73			Supramolecular chemistry and functional inorganic systems	3-0-0-6	PG
74			Colloids and Surface Chemistry	3-0-0-6	PG
75			Fundamentals of biophysical chemistry	3-0-0-6	PG
76			Green and sustainable Chemistry	3-0-0-6	PG
77			Analytical Chemistry	3-0-0-6	PG
78			Principles of Biological Chemistry	3-0-0-6	PG
79		CH508T	Computational Chemistry	3-0-0-6	PG
80			Asymmetric Synthesis and Catalysis: From Basics to Frontiers	3-0-0-6	PG
81			Chemistry of carbohydrates	3-0-0-6	PG
82			Mathematics for Chemists	3-0-0-6	PG
83			Radioactivity and Nuclear chemistry	3-0-0-6	PG
84			Electrochemistry and its Applications	3-0-0-6	PG
85		CH413T	Symmetry and Group theory	3-0-0-6	
86		CH401P	Minor Project		
87		CH515T	Instrumental Methods for Structure Determination	3-0-0-6	
88		CH516T	Conceptsin organic synthesis	3-0-0-6	
89		CH703T	Advanced computational chemistry Advanced **computational chemistry**	3-0-0-6	

1	**Title of the course** (L-T-P-C)	**Fundamental Concepts &Applications of Chemistry (2-1-0-6)**
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. 1. P. Atkins, J. de Paula, "physical chemistry" 5th Edition, Oxford. 2. J. Clayden, N. Greeves, S. Warren, "Organic chemistry" 2th Edition, Oxford. 3. George Odian, Principles of polymerization, 4th edition, Wiley student edition, Wiley India Pvt Ltd. 4. F. W. Billmeyer, Text book of Polymer Science, 3rd edition, Wiley student edition, Wiley India Pvt Ltd. 5. A. K. De, Environmental Chemistry, 8th edition, New Age International publishers. 6.B. K. Sharma, Environmental Chemistry, 16th edition, Krishna Prakashan Media Pvt Ltd. 7. A. R. West, Solid State Chemistry and Its Applications, Wiley student edition, Wiley India Pvt Ltd. 8. T. Pradeep, Nano: The essentials, McGraw-Hill Education publishers. 9. Geoffrey A Ozin and André Arsenault, Nanochemistry: A Chemical Approach to Nanomaterials, 2nd edition, RSC publishing.

1	**Title of the course** (L-T-P-C)	**Chemistry Lab (0-0-3-3)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Experiments illustrating the concepts of 1) Electrochemical Cell, (2) Chemical kinetics, (3) Estimation of Iron, (4) Oscillatory Chemical Reactions, (5a) Electrolytic Conductance (5b) Crystalline Solids (6) Colorimetric Analysis (7) Complexometric Titration (8) Thin Layer Chromatography
4	**Texts/References**	1. Physical Chemistry, P.W. Atkins, 5th Edition (ELBS/OUP) 1994. 2. Vogel's Textbook of Quantitative Analysis revised by G. H. Jeffery, J. Basset J. Mendham and R. C. Denny, 5th Edition. 3. Organic Chemistry, Morrison and Boyd, 6th Edition. 4. "Patterns in Time and Space - Generated by Chemistry", I. R. Epstein, C and E News, March 1987. 5. "An Oscillating Iodine Clock", T. S. Brigg and W.C. Rauischer, Journal of chemical education., Vol no. 50, Issue no 7, Page no 496, year 1973. 6. "Oscillating Chemical Reactions",I.R. Epstein, K. Kustin, P. DeKepper and M. Orban, Scientific American, Vol no.248, Page no.112, year 1983. 7. "Physical Chemistry", G.K.Vemulapalli (1997). 8. Calimente, S.; Strand, S. M.; Chang, S-C.; Lewis, D. E. J. Chem. Ed. 1999, 76, 82-83. 9. Wagner, A.J.; Miller, S.M.; Naguyen, S.; Lee, G. Y.; Rychnovsky, S.; Link, R.D. J. Chem. Ed. 2014, 91, 716- 721.

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)	**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)	**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)	**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)	**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)	**Sustainable energy and energy materials** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	Fuel cells, catalysis for fuel cells and sustainable chemical processes • Batteries • Solar photovoltaics Wind power: practical aspects • Tidal power • Inorganic, Organic and functional biomaterials as energy materials
4	**Texts/References**	

1	**Title of the course** (L-T-P-C)	**Bioenergy and Biofuels** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Exposure to basic concepts in biochemistry, chemistry, energy
3	**Course content**	Introduction to bioenergy, basics of biomass technology and resources, cellular metabolism and bioenergetics, quantitative methods, enzymes involved in bioenergy production, biofuels (biodiesel, bio methanol, biomethane, bioethanol, biobutanol, biohydrogen etc.) sources and uses, bioenergy crops, fermentation and photobiological methods, microbial production of biofuels, bioreactors, bio gas, microbial fuel cells, thermal conversion technologies and gasification, biooil and biopower, biorefineries, bioenergy systems analysis, economics, bioenergy for a sustainable future
4	**Texts/References**	1. Y. Li, and S. K. Khanal, "Bioenergy: Principles and applications" Wiley-Blackwell, 1st Edition, 2016. 2. N. G. Halford "An introduction to bioenergy" Imperial college press,1st edition, 2015. 3. O. Konur, "Bioenergy and biofuels," CRC press, 1st edition, 2017. 4. A. Dahiya, "Bioenergy: Biomass to biofuels," Academic press, 1st edition, 2014 5. C. Drapcho, N.P. Nhuan, T. Walker, "Biofuels Engineering Process Technology" McGraw Hills, 1st Edition, 2008. 6. J. Cheng Ed. "Biomass to Renewable Energy Processes" CRC press, 1st Ed, 2017.

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 Sophisticated characterization Techniques (2-0-2-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	Module 1: Nuclear Magnetic Resonance spectroscopy - Introduction to NMR • instrumentation • working principle • Basic principles of analysis • characterization of different samples Module 2: Spectrophotometer and Spectrofluorimeter - Fundamental concepts • Instrumentation • Basic principles of analysis • characterization and analysis of samples Module 3: Atomic Force Microscope – Instrumentation • Physics and working principle • Different modes of operation • Different imaging techniques • Analysis of the data • Niche applications. Module 4: Field Emission Scanning Electron Microscope – Introduction to electron microscopy • Different signals generated • Vacuum systems • Instrumentation • working principle • Imaging methods and different parameters associated to them Module 5: Universal Test machines – Overview of Mechanical properties under static and dynamic loads • Introduction to UTMs • Introduction to UTM accessories • Introduction to Static tests • Introduction to Fatigue tests • Introduction to Fracture Mechanics tests
4	**Texts/References**	1. G. E. Dieter, Mechanical Metallurgy, 3rd Edition, McGraw Hill Education India, 1986 2. J. R. Davis, Tensile Testing, 2nd Edition, ASM International, 2004. 3. J. R. Lakowicz, Principles of fluorescence spectroscopy, 3rd Edition,2006 4. H. Gunther, NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry, 3rd Edition, 2013. 5. Banwell Colin, Fundamentals for Molecular Spectroscopy 4th Edition.

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)	**Instrumental methods for structure determination (2-1-0-6)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	NMR spectroscopy: Basic principles of ^{1}H-NMR, instrumentation and interpretation of NMR spectrum, chemical shift: principles, chemical shift values of major organic compound classes, and factors affecting chemical shift, spin-spin coupling, spin systems, coupling with other nuclei, 2D-NMR (COSY, TOCSY), NOE (NOESY), ^{13}C-NMR- principles and chemical shifts for major organic compound classes, ^{1}H- ^{13}C-2D NMR (HSQC, HMBC), DEPT, ^{31}P and ^{19}F-NMR, solid state NMR and applications in chemistry. Mass Spectrometry: Instrumentation and techniques (ionization techniques, mass analysers, and detection techniques, tandem MS or MS/MS, LC-MS, GC-MS, MALDI-TOF-MS etc.), interpretation of mass spectra, fragmentation patterns of major organic compound classes including rearrangement reactions and applications of mass spectrometry in chemistry and biology. FTIR and UV-Visible spectroscopy: Basic concepts and applications in functional group characterization and organic structure elucidation
4	**Texts/References**	1. R. Silverstein, F. Webster, D. Kiemle, and D. Bryce "Spectrometric identification of organic compounds", 8th Ed., Wiley, 2015. 2. P. Crews, J. Rodriguez, and M. Jaspars, "Organic structure analysis", 2nd Ed., OUP USA, 2009. 3. D. Williams and I. Fleming, "Spectroscopic methods in organic chemistry", 6th Ed., McGraw Hill Education, 2011. 4. W. Kemp, "Organic spectroscopy", 2nd Ed., Red Globe Press, 2019. 5. D. Pavia "Introduction to spectroscopy" Cengage Learning India Private Ltd., 5th Ed., 2015. 6. C. Banwell and E. McCash "Fundamentals of molecular spectroscopy" 4th Ed., McGraw Hill Education, 2017. 7. J. Keeler "Understanding NMR spectroscopy" 2nd Ed., Wiley, 2011. 8. K. Chary and G. Govil "NMR in biological systems: from molecules to human" 1st Ed., Springer, 2008.

1	**Title of the course** (L-T-P-C)	**Non-transition and transitional metal chemistry (2-1-0-6)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Chemistry of Transition metals: Introductory survey of transition elements with reference to electronic configuration, oxidation states, complex compounds. Introductory concepts of molecular symmetry. Spectral and magnetic properties. Chemistry of titanium, vanadium, chromium, manganese sub-group elements, iron, cobalt, nickel, platinum metals, copper and zinc sub-group elements, group III, IV, V, VI, VII and rare gases with reference to isolation, properties, uses and important compounds. Chemistry of Lanthanides and Actinides: Electronic configuration, colour and magnetism, properties of lanthanides and actinides. Synthesis of trans-Uranic elements, chemistry of uranium compounds. Chemistry of Non-transition metals: Non-transition elements, stereochemistry and bonding in non-transition elements and compounds: alkali metals, metal hydrides and dihydrogen complexes, the boron and carbon groups, the nitrogen and oxygen groups, the halogens and the noble gases. Review of inorganic chains, rings and cages.
4	**Texts/References**	• F. A. Cotton and G. Wilkinson, Basic Inorganic Chemistry, Wiley Easter, 1978. • M. J. Sienko and R.A. Plane, Chemical Principles and Properties, McGraw Hill, 1975. J. D. Lee, Concise Inorganic Chemistry, Van Nostrand Reinhold, 1977 • J. E. Huheey, E. A. Keiter, and R. L. Keiter, Inorganic Chemistry – Principles of Structure and Reactivity, 4ed, Pearson Education, 2006 • Inorganic Chemistry. D. F. Shriver, and P. W. Atkins. 3rd Edn. Oxford University, Oxford, 1999. • Chemistry of the Elements, by N.N. Greenwood and A. Earnshaw, Butterworth-Heinmann, London, (1997). Advanced Inorganic Chemistry by F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, John Wiley, Chichester, (1999).

1	**Title of the course** (L-T-P-C)	**Chemical Bonding and Symmetry** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Postulates of quantum mechanics; hermitian operators; complete set. Derivation of the uncertainty relations. Exactly solvable problems, orbital angular momentum, and the hydrogen atom. Spin, spin orbitals, and characteristics of a many-electron wave function. Variation theorem, variation method, the linear variation method, and the non-crossing rule. Applications: Many-electron atoms, self-consistent field, atomic orbitals, Slater Type Orbitals, Time-dependent and time dependent perturbation theory The valence bond treatment of hydrogen molecule; Resonance; Polarity and dipole moment; Electronegativity; Valence-bond wave functions for polyatomic molecules. Introduction to molecular symmetry, point groups, characters and character tables and applications in atomic structure and spectroscopy, Structures of different lattices and diffraction methods
4	**Texts/References**	1. R. McWeeny, Coulson's Valence, Oxford University Press, 1979. 2. D. A. McQuarrie, Quantum Chemistry, Oxford University Press, 1983. 3. I. R. Levine, Quantum Chemistry, Prentice Hall India (Ltd), 1995. 4. P. Atkins, J. de Paula and J. Keeler, Atkins' Physical Chemistry, 11th Ed.,OUP (2018).

1	**Title of the course** (L-T-P-C)	**Organic reactions and reagents** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Functional group transformations, common named reactions, oxidations, reductions and rearrangements and their applications in organic synthesis. Carbon-Carbon Bond Forming Reactions *via* enolate, enamine and imine chemistry, Grignard, cuprate and other conjugate reactions, Radical reactions and other classes (via organo silane, borane and tin based reagents, Baylis-Hillman reaction), Selectivity and protecting groups: Illustration of chemoselectivity, regioselectivity and enantioselectivity, stereoselectivity; protecting groups for alcohols, amines, acids, ketones and aldehydes. common catalysts and reagents for reactions (organic, inorganic, organometallic and enzymatic), pericyclic and photochemical reactions in organic synthesis
4	**Texts/References**	1. Carey, F. A., Sundberg, R. J. *Advanced Organic Chemistry*, *Part A and B*, Springer, 2007. 2. Clayden, J., Greeves, N., Warren, S., Wothers, S. *Organic Chemistry*, Oxford University Press, **2001**. 3. Carruthers, W., Coldham, I. *Some Modern Methods of Organic Synthesis*, Cambridge University Press, **2004**. 4. Smith, M. B. and March, J. *Advanced Organic Chemistry*, Wiley Interscience, **2007**. 5. G. S. Zweifel and M. H. Nantz, *Modern Organic Synthesis-An Introduction*, W. H. Freeman and Company, 2006 6. K. Peter C. Vollhardt and Neil E. Schore "Organic Chemistry" W. H. Freeman and Company, 1999. 7. T.W. Greene, "*Protecting Groups in Organic Synthesis"* (3rd edition), J. Wiley & Sons, **1999**.

1	**Title of the course** (L-T-P-C)	**Chemistry laboratory-I** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	
3	**Course content**	Inorganic chemistry: Basic concepts of quantitative analysis, redox, precipitation and complexometric titrations. Solubility product and precipitation, organic precipitants and extractants. A brief survey of separation methods: solvent extraction and chromatography. Volumetric analysis involving redox, precipitation and complexometric titrations. Organic chemistry: Determination of physical constants, purification of solids and liquids and methods of checking their purity. Separation of enantiomers and measurements of optical rotation. Studies of electrophilic/nucleophilic substitution reactions, redox reactions Physical chemistry: 1. Ionization constant by spectrophotometry, enzyme kinetics, use of immobilized enzyme electrode, adsorption isotherm
4	**Texts/References**	

1	**Title of the course** (L-T-P-C)	**Chemistry laboratory-III (0-0-3-3)**
2	**Pre-requisite courses(s)**	
3	**Course content**	Inorganic chemistry: Determination of composition of complexes in solution. Synthesis and characterization of transition metal complexes (including organometallic compounds) and their study by various methods (spectral, thermal and magnetic etc). Organic chemistry: Chemical separation of ternary mixtures and characterization of the components. Simple one or two step preparations involving different techniques, Isolation of natural products, chromatographic analysis of complex mixtures, selectivity in synthesis, enzymatic and chemo-enzymatic synthesis, characterization Physical chemistry: Determination of the following physical quantities: partial molal volumes, dipole moments, activities by freezing point, quantum yields, heats of vaporisation and depressions of freezing points of solutions, velocity constant and activation energy. Electrodes with different substrates for H2 evolution, photoelectrochemical solar cells.Vacuum measurement. IR spectrum of HCl, Use of M.O. theory, solution of Schrodinger equation for polyatomics.
4	**Texts/References**	

1	**Title of the course** (L-T-P-C)	**Chemistry laboratory-IV** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	
3	**Course content**	Exposure to various instruments such as UV-Vis-NIR spectrophotometer, Fluorimeter, Nuclear Magnetic resonance spectrometer, Infra-red spectrophotometer, mass spectrometer, and chromatographic techniques (HPLC, GCMS, LCMS, MALDI, Combiflash), CHN analyzer, Powder X-ray diffraction etc.
4	**Texts/References**	

1	**Title of the course** (L-T-P-C)	**Molecular Energetics and Dynamics** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Laws of thermodynamics. Estimations of enthalpy and free energy. Fugacity and activity and their determinations Application to chemical reactions. Overview of rate laws and determining rates and orders of reactions. Complex Reactions. Catalysis. Temperature dependence and Arrhenius law. Potential energy surfaces. Kinetic theory of collisions. Transition state theory. RRK and RRKM theories. Reaction cross-sections, rate coefficients, reaction probabilities. Photochemical reactions. Ultrafast reactions. Diffusion in solids, liquids and solutions. Chemical oscillations and nonlinear dynamics.
4	**Texts/References**	1. P. Atkins and J. de Paula, Atkins' Physical Chemistry, 8th edition, Oxford University Press, 2006. 2. G. W. Castellan, Physical Chemistry, 3rd edition, Addison - Wesley/Narosa Publishing House, 1993. 3. G. N. Lewis and M. Randall, Thermodynamics, (Revised by K. S. Pitzer and L. Brewer), International Students Edition, McGraw Hill, 1961. 4. Chemical Kinetics and Dynamics, Jeffrey I. Steinfed, Joseph S. Francisco and William L. Hase. 5. Chemical Kinetics and Reaction Dynamics, Paul L Houston

1	**Title of the course** (L-T-P-C)	**Concepts in organic synthesis** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101) and organic reactions and reagents
3	**Course content**	Synthesis, reactions, mechanisms, and selectivity involving the following-alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives, halides, nitro compounds and amines. Use of compounds of Mg, Li, Cu, B and Si in organic synthesis. Concepts in multistep synthesis- retrosynthetic analysis, disconnections, synthons, synthetic equivalents, linear and convergent synthesis, reactivity umpolung, selectivity, protection and deprotection of functional groups, Asymmetric synthesis: Chiral auxiliaries, methods of asymmetric induction – substrate, reagent and catalyst-controlled reactions; enantiomeric and diastereomeric excess; enantio-discrimination. Resolution – optical and kinetic.
4	**Texts/References**	• Clayden, J., Greeves, N., Warren, S., Wothers, S. *Organic Chemistry*, Oxford University Press, **2001**. • Carruthers, W., Coldham, I. *Some Modern Methods of Organic Synthesis*, Cambridge University Press, **2004**. • Smith, M. B. and March, J. *Advanced Organic Chemistry*, Wiley Interscience, **2007**. • Carey, F. A., Sundberg, R. J. *Advanced Organic Chemistry*, *Part A and B*, Springer, **2007**. • Smith, M. B. *Organic Synthesis*, McGraw-Hill, **2001**. • Warren, S. *Organic Synthesis: The Disconnection Approach*, Wiley, **1983**. G. S. Zweifel and M. H. Nantz, *Modern Organic Synthesis-An Introduction*, W. H. Freeman and Company, 2006

1	**Title of the course** (L-T-P-C)	**Molecular spectroscopy** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Introduction to spectral energy domains and measurement of spectra, Implications of discrete energy levels, Population of States – Boltzman Distribution, Interaction of radiation with matter, origin of linewidths in molecular spectra, Transition dipole moment and Fermi's Golden Rule, Einsteins Coefficients, Lasers and Masers. Rotational (Microwave) spectroscopy, Molecular vibrations - Infrared spectroscopy, Normal mode analysis, Raman Scattering, Selection Rules from Group Theory, Molecular electronic spectra, Photophysical processes, Non-Linear Spectroscopy, Nuclear Magnetic Resonance, Relaxation times, FT-NMR, spin-spin coupling, ESR, Nuclear Quadrupolar Resonance.
4	**Texts/References**	1. J. L. McHale, Molecular Spectroscopy, Pearson Education, 1999. 2. M. Hollas, Modern Spectroscopy, Wiley; 4th edition, 2004. 3. F. A. Cotton, Chemical Applications of Group Theory, 3rd edition, Wiley-Interscience, 1990. 4. D. C. Harris, M. D. Bertolucci, Symmetry and Spectroscopy, Dover, 1990. 5. C. M. Banwell, E. M. McCash, Fundamentals of Molecular Spectroscopy, Tata McGraw Hill, 1983 6. G. M. Barrow, Molecular Spectroscopy, McGraw Hill, 1962 7. J. I. Steinfeld, Molecules and Radiation: An Introduction to Modern Molecular Spectroscopy, 2nd edition, Dover, 2005. 8. J. D. Graybeal, Molecular Spectroscopy, McGraw Hill 1993. 9. D. A. McQuarrie and J. D. Simon, Physical Chemistry - a molecular approach, Viva Books Pvt. Ltd. 1998.

1	**Title of the course** (L-T-P-C)	**Coordination and organometallic chemistry** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101) and Transitional metals and coordination chemistry.
3	**Course content**	*Coordination compounds:* Valence bond theory, crystal field theory, molecular orbital theory and their applications, inner sphere electron transfer, outer sphere electron transfer, classification of ligands, trans effect, stability constant, Jahn-Teller effect, ploy nuclear complexes, reaction of coordination compounds. Bonding and Electronic Spectra: MO theory of transition metal complexes spectroscopic term symbols, selection rules, Orgel diagrams, and charge transfer bands; Magnetism of Coordination Complexes. *Organometallic chemistry*: General concepts: Types of ligands, soft *vs* hard ligands. 18e rule and its exceptions, isolobal and isoelectronic analogies. s and π bonding, Structure, bonding and reactivity studies of metal carbonyls, nitrosyls, dinitrogen complexes. Organometallic Reactions and Mechanisms: oxidative addition, reductive elimination reactions, organometallic complexes with metal-metal bonds. Metal–ligand Multiple Bonds: Fischer and Schrock type carbene complexes, carbyne complexes, and metal–heteroatom (O/N) multiple bonds
4	**Texts/References**	• R. H. Crabtree, The Organometallic Chemistry of the Transition Metals, 6ed, Wiley, 2013. • J. Hartwig, Organo-transition Metal Chemistry: From Bonding to Catalysis, University Science Books, 2010. • B. D. Gupta and A. J. Elias, Basic Organometallic Chemistry: Concepts, Syntheses and Applications, 2ed, Universities Press, 2013. • G. L. Miessler and D. A. Tarr, Inorganic Chemistry, 3ed, Pearson, 2008. • B. Douglas, D. McDaniel, and J. Alexander, Concepts and Models of Inorganic Chemistry, 3ed, Wiley, 2010. • J. E. Huheey, E. A. Keiter, and R. L. Keiter, Inorganic Chemistry – Principles of Structure and Reactivity, 4ed, Pearson Education, 2006 • Inorganic Chemistry. D. F. Shriver, and P. W. Atkins. 3rd Edn. Oxford University, Oxford, 1999. • S. F. A. Kettle, Physical Inorganic Chemistry – A Coordination Chemistry Approach, Springer, 1996.

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

1	**Title of the course** (L-T-P-C)	**Statistical Mechanics** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Ensembles and Averages, equivalence of Ensembles, classical Limit. Monte Carlo and Molecular Dyamics simulations. Distribution functions at equilibrium. Integral equation methods. Perturbation theory. Density functional methods. Molecular fluids. Estimation of thermodynamic functions. Non-equilibrium methods. Linear response theory. Stochastic processes and Brownian motion. Selected applications to problems in chemical dynamics, relaxation processes and neutron diffraction.
4	**Texts/References**	1. D. A. McQuarrie, *Statistical Mechanics*, Harper and Row,1974. 2.M. P.Allen and D. J. Tildesley, *Computer Simulation in Liquids*, Oxford University Press, 1987. 3.J. P. Hansen and I. R. McDonald, *Theory of Liquids*, 2nd edition, Academic Press,1986. 4.D. Chandler, *Statistical Mechanics*, Oxford University Press, 1985. 5.H. L. Friedman, *A Course in Statistical Mechanics*, Prentice Hall,1983

1	**Title of the course** (L-T-P-C)	**Quantum Field Theory** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Successfully finishing first 3 Years of BTech Course
3	**Course content**	Introduction: Review of Classical field Theories and the need for Quantum Field Theory Bosonic Fields: Second quantization of bosons; non-relativistic quantum fields and the Landau Ginzburg theory; relativistic free particles and the Klein-Gordon field; causality and the Klein-Gordon propagator; quantum electromagnetic fields and photons. Fermionic Fields: Second quantization of fermions; particle-hole formalism; Dirac equation and its non-relativistic limit; quantum Dirac field; spin-statistics theorem; Dirac matrix techniques; Lorentz and discrete symmetries. Interacting Fields and Feynman Rules: Perturbation theory; correlation functions; Feynman diagrams; S-matrix and cross-sections; Feynman rules for fermions; Feynman rules for QED. Functional Methods: Path integrals in quantum mechanics; "path" integrals for classical fields and functional quantization; functional quantization of QED; QFT and statistical mechanics; symmetries and conservation laws. Quantum Electrodynamics: Some elementary processes; radiative corrections; infrared and ultraviolet divergencies; renormalization of fields and of the electric charge; Ward identity. Renormalization Theory: Systematics of renormalization; `integration out' and the Wilsonian renormalization; `running' of the coupling constants and the renormalization group. Non-Abelian Gauge Theories: Non-abelian gauge symmetries; Yang-Mills theory; interactions of gauge bosons and Feynman rules; Fadde'ev-Popov ghosts and BRST; renormalization of the YM theories and the asymptotic freedom; the Standard Model.
4	**Texts/References**	1.“An Introduction to Quantum Field Theory”, Michael Peskin and Daniel Schroeder (Addison Wesley) 2. “Introduction to Quantum Field Theory”, A. Zee 3.“Quantum Field Theory”, Lewis H. Ryder 4. “Quantum Field Theory and Critical Phenomena”, by Jean Zinn-Justin. 5.“Quantum field Theory for the Gifted Amateur”, T. Lancaster and Stephen J. Blundell 6.NPTEL lectures in Quantum Field Theory (https://nptel.ac.in/courses/115106065/)

1	**Title of the course** (L-T-P-C)	**Chemical biology and medicinal chemistry (3-0-0-6)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Fundamental principles of chemical biology, Chemistry and biochemistry of biomolecules (DNA, RNA, proteins, lipids, and carbohydrates), Enzyme chemistry and reaction mechanisms, chemistry of biological pathways, Basic medicinal chemistry, Chemistry of drug design and drug action, Drug targets, Natural products classes as drug leads (PKS, NRPS, RiPP, terpenes, alkaloids, macrolides etc.), Chemical control of signal transduction, antibiotics, antifungals, antivirals, antidiabetic and anticancer drugs, drug resistance
4	**Texts/References**	1. R. Silverman, "The organic chemistry of enzyme catalyzed reactions" Revised ed., Academic Press, 2002. 2 D. Vranken and G.A. Weiss "Introduction to Bioorganic Chemistry and Chemical Biology" 1st Ed., Garland Science, 2012. 3. McMurry and Begley "The Organic Chemistry of Biological Pathways" 2nd ed., WH Freeman, 2015 4. Nelson and Cox, "Lehninger Principles of Biochemistry", 7th Ed., WH Freeman, 2017 5. Silverman and Holladay "The Organic Chemistry of Drug Design and Drug Action" 3rd Ed., Academic press, 2014 6. P. Frey and A. D. Hegeman, "Enzymatic Reaction Mechanisms", 1st Ed., OUP USA, 2007. 7. P. Bruice, "Organic Chemistry" 7th Ed., Pearson, 2013. 8 Wiley Encyclopedia of Chemical Biology (Editor: T. Begley), 1st ed., Wiley-Blackwell, 2009 (4 volumes)

1	**Title of the course** (L-T-P-C)	**Our Health and Medicine** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	Health and nutrition**,** role of different nutrients (carbohydrates, proteins, fats, vitamins, and minerals), diet and metabolism, basic introduction to human physiology, communicable diseases (common bacterial and fungal infections, antibiotics and resistance, common viral infections, corona virus (SARS, MERS, SARS- COV-2), vaccine and antivirals, non-communicable diseases (diabetes, cancer), basic medicinal chemistry, preventative and community medicine, health policies, healthcare system, health awareness and best practices
4	**Texts/References**	1. Oxford textbook of medicine: Infection ed. by David Warrell and Timothy Cox, 1st edition, OUP, 2012. 2. Textbook of community medicine ed. by Rajvir Bhalwar, 2nd edition, Wolters Kluwer, 2017. 3. Koneman's textbook of diagnostic microbiology, 7th edition, Wolters Kluwer, 2017. 4. Principles of therapeutic nutrition and dietetics, by Avantina Sharma, 1st edition, CBS, 2017. 5. Textbook of medical biochemistry by Rajinder Chawla, E.H. El-Metwally and Suchanda Sahu, 2nd edition, Wolters Kluwer, 2017. 6. An introduction to medicinal chemistry by Graham L. Patrick, 3rd edition, OUP, 2005.

1	**Title of the course** (L-T-P-C)	**Material science and polymer chemistry (3-0-0-6)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Atomic Bonding, Crystal Structure and Defects, Mechanical and Thermal Behaviour, Metals and alloys, Semiconductors, Ceramics & Glasses, Mechanical properties of inorganic and composite materials. Biomaterials. 1. Basic characteristics of polymers, glass transition temperature, crystallinity, molecular weight and molecular weight distribution. Various types of Polymer Synthesis characterization; Chemical analysis of polymers; Conducting polymers and their applications in optoelectronics and sensors
4	**Texts/References**	1. Introduction to Materials Science for Engineers; 8th Edition James F. Shackelford 696 pages; Pearson (April 12, 2014) 2. Materials Science and Engineering: An Introduction; 9th Edition William D. Callister Jr. and David G. Rethwisch 984 pages; Wiley (December 4, 2013) 3. M. Campbell, Introduction to Synthetic Polymers, 2nd Ed, Oxford University Press, New York (2000) 4. Principles of polymerization: G. Odian, 4th Edition, John Wileyinterscience 5. Conducting polymers, fundamentals and applications: A practical approach, Prasanna Chandrasekhar, Springer Science+Business media

1	**Title of the course** (L-T-P-C)	**Bioinorganic and biophysical chemistry (3-0-0-3)**
2	**Pre-requisite courses(s)**	Transitional metals and coordination chemistry
3	**Course content**	Oxygen-activating proteins (cytochrome P450 and cytochrome c oxidase), electron transport proteins (blue copper proteins, Fe–S clusters, and cytochromes), photosystems, and hydrolase enzymes (carbonic anhydrase and peptidase). Metal transport and storage – Ferritin, Haemoglobin and myoglobin, Metals in medicine. Structure of water, hydrophilic and hydrophobic interactions, Structure and conformations of proteins and nucleic acids, physical techniques for biological structure elucidation, thermodynamics and kinetics of ligand interactions and protein folding, Conformational transitions, Equilibrium across membranes
4	**Texts/References**	1. W. Kaim and B. Schwederski, Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life, 2ed, Wiley, 2013. 2. R. R. Crichton, Biological Inorganic Chemistry - An Introduction, Elsevier, 2008. 3. Principles of Bioinorganic Chemistry, Stephen J. Lippard, Jeremy Mark Berg, 1994, University Science Publications 4. R. B. Gregory, ed., Protein-Solvent Interactions, Marcel Dekker,Inc., 1995. 5. B.T. Nall and K. A. Dill, ed., Conformations and Forces in Protein Folding, American Association for the Advancement of Science, 1991. 6. J. Wyman and S. J. Gill, Binding and Linkage: Functional Chemistry of Biological Macromolecules, University Sciences Books, 1990. 7. 7. C. R. Cantor and P. R. Schimmel, Biophysical Chemistry, Part III, W.H.Freeman and Co.,1980.

1	**Title of the course** (L-T-P-C)	**Solid State Chemistry and its Applications** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Diffraction techniques and the structure of solids; analysis of diffraction data. Crystal defects, nonstoichimetry and solid solutions. Structure of solid electrolytes, zeolites, Solid state transformations and reactions. Electronic structure of solids: Fermi level, Bloch orbitals, energy bands, Brillouin zone. Electric and magnetic properties of solids: insulators, semiconductors, conductors and Fermi surfaces; superconductivity; polarization, refractive index, dielectrics and ferroelectrics; diamagnetism and paramagnetism; ferromagnetism, ferrimagnetism and antiferromagnetism. Molecular metals, phosphors and solid state lasers. Introduction to nanoscience.
4	**Texts/References**	C. Kittel, *Introduction to Solid State Physics*, 6th edition, Wiley, 1991. A. R. West, *Solid State Chemistry and Its Applications*, Wiley, 1989. P. A. Cox, *Electronic Structure and Chemistry of Solids*, Oxford University Press, 1991. **4.** A. W. Adamson, *Physical Chemistry of Surfaces*, Wiley, 1990

1	**Title of the course** (L-T-P-C)	**Supramolecular chemistry** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101) and Main group chemistry and Transition metals and coordination chemistry
3	**Course content**	Basic concept and principles; Terminologies and nomenclature in supramolecular chemistry. Chemical interactions leading to supramolecular assemblies (Hydrogen Bonds, Non-covalent interactions), Molecular recognition and host-guest complementarity. Biological supramolecular systems: Ionophores, Porphyrin and other Tetrapyrrolic Macrocycles, Coenzymes, Neurotransmitters, DNA and Biochemical Self-assembly. Supramolecular reactivity Biomimetic systems and Artificial receptors (Cation Binding Hosts, Anion binding hosts, Ion Pair Receptors, Hosts for Neutral Receptors) Organic Crystal Structures, Polymorphism, Solvates, Co-Crystals.
4	**Texts/References**	1. J.M.Lehn, Supramolecular Chemistry: Concepts and Perspectives, Wiley VCH, Weinheim (1995). 2. V. Balzani (Editor), L. De Cola, Supramolecular Chemistry, Kluwer, Dordrecht (1992). 3. Supramolecular Chemistry by J. W. Steed & J. L. Atwood, 2ndEdn John Wiley, 2009. 3. Crystal Engineering. The Design of Organic Solids by G.R. Desiraju, Elsevier, 1989.

1	**Title of the course** (L-T-P-C)	**X-ray crystallography and applications** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Geometric Crystallography: Lattices, point groups and space groups, and lattice transformations. Processing raw diffraction data: Diffraction data statistics, temperature & scale factor determination, density measurements and calculations, molecular formula and molecular weight determination, space group determination. (c) Structure determination: Heavy atom Patterson methods, direct methods, isomorphous replacement methods. Refinement: isotropic and anisotropic, atom fix and hydrogen fixations, riding models. Interpretation of the structural data: metric parameters, dihedral data, H-bond data, preparation of structure plots including ORTEP and lattice structures including packing diagrams. Practical exercise of structure determination using standard packages: one centro-symmetric and one non-centrosymmetric crystal data.
4	**Texts/References**	• X-ray structure determination: A practical guide, G.H. Stout and L.H. Jensen, Wiley, Second Edition 1989. • Foundations of Crystallography with Computer Applications, M.M. Julian, CRC Press, 2008. • An Introduction to X-ray Crystallography, M.M. Woolfson, Cambridge University Press; 1970.

1	**Title of the course** (L-T-P-C)	**Seminar** **(2-0-0-4)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	NA
4	**Texts/References**	NA

1	**Title of the course** (L-T-P-C)	**Computational chemistry** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Introduction to computer programming in Fortran, Elementary programming methods, arrays, do loops, functions and subroutines. Elementary numerical methods, error analysis, interpolations, matrix methods, integration, differential equations, integral transforms and random numbers. Use of Scilab in numerical methods and graphics. Classical molecular dynamics and Monte Carlo Simulations. Use of Gromacs software for classical molecular dynamics
4	**Texts/References**	1. T. R. McCalla, Introduction to Numerical Methods and Fortran Programming (1967), Amazon Books 2. M. P. Allen and D. J. Tildesley, Computer Simulation of Liquids, Oxford University Press (1990) 3. NPTEL/MOOCS videos and course materials on Computational Chemistry 4. Gromacs manual

1	**Title of the course** (L-T-P-C)	**Bioorganic chemistry and Chemical Biology** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Aminoacids, peptides and proteins: physicochemical properties and chemical synthesis; peptide bond formation, amino acid analysis and peptide sequencing; brief introduction to ribosomal protein synthesis; combinatorial chemistry; enzyme chemistry; proteins as drug targets. Carbohydrates: Introduction; structure, configuration, and conformation; common protecting groups and protecting group strategies; glycosylation: general concepts, various methods of glycoside bond formation; strategies in oligosaccharide synthesis: carbohydrate-based drug discovery. Nucleic acids: Introduction, structure, chemical and enzymatic synthesis, DNA, RNA polymerases, ligases, restriction enzymes, PCR and sequencing, nucleic acid as drug targets, ribozymes, DNA enzymes and riboswitches; antisense, RNA interference and aptamers; DNA damage and repair. Structure, function, physicochemical properties of lipids and fatty acids Biological chemistry and principles of chemical biology, Chemistry of biological pathways, role of chemistry in understanding biology
4	**Texts/References**	1. P. Lloyd-Williams, F. Albericio, E. Giralt, Chemical Approaches to the Synthesis of Peptides and Proteins, 1st Edition, CRC Press, Boca Raton,1997 2. S. Doonan, Peptides and Proteins, 1st Edition, RSC Publishing House, London, 2002 3. T. Bugg, An Introduction to Enzyme and Coenzyme Chemistry, 2nd Edition, Blackwell Science, Oxford, 2004 4. B. G. Davis & A.J. Farbanks, Carbohydrate Chemistry, 1st Edition, Oxford University Press, 2002 5. R. V. Stick., Carbohydrates: The Essential Molecules of Life, 2nd Edition, Academic Press, 2009 6. D. E. Levy and P. Fugedi, The Organic Chemistry of Sugars, CRC Press, 2006 7. G. M. Blackburn, M. J. Gait, D. Loakes, D. M. Williams, Nucleic Acids in Chemistry and Biology, 3rd Edition, RSC Publishing, London, 2006 8. S. Doonan, Nucleic Acids, 1st Edition, RSC Publishing House, London, 2000 9. 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)	**Pericyclic reactions and photochemistry (3-0-0-3)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Conservation of orbital symmetry, Woodward-Hoffmann rules, frontier molecular orbital (FMO) theory, Orbital overlap effects in cycloadditions, electrocyclizations, sigmatropic rearrangements and chelotropic reactions, Paterno-Buchi, Norrish type I and II reactions, Photochemistry of alkenes, carbonyl compounds, and arenes. Photooxidation and photoreduction. Di- π- methane rearrangement, Barton reaction, photocatalysis. Cycloaddition reactions: Diels-Alder reaction; hetero-Diels Alder reaction. 1,3-dipolar cycloaddition reactions; [2+2] cycloaddition reactions; Molecular rearrangements; Sigmatropic rearrangements, Cope and oxy- Cope rearrangements; 2,3-sigmatropic rearrangements and ene reaction.
4	**Texts/References**	1. F. A. Carey and R. J. Sundburg, "Advanced Organic Chemistry, Part B", Fifth Ed., Plenum Press, 2007. 2. J. Clayden, N. Greeves, S. Warren and P. Wothers, "Organic Chemistry", First Ed., Oxford University Press, 2001. 3. T. L. Gilchrist and R. C. Storr, "Organic Reactions and Orbital Symmetry", 2nd Edn., Cambridge University Press, Cambridge, 1979. 4. K. K. Rohatagi-Mukherjee, *Fundamentals of Photochemistry*, Wiley Eastern, 1978. 5. I. Fleming, "Pericyclic Reactions", Oxford University Press, Oxford, 1998. 6. S. Sankararaman, "Pericyclic Reactions- A Textbook", Wiley- VCH, Weinheim, 2005. 7. M. Klessinger and J. Michl, "Excited States and Photochemistry of Organic Molecules", VCH Publishers, Inc., New York, 1994.

1	**Title of the course** (L-T-P-C)	**Heterocyclic chemistry and natural products (3-0-0-3)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Significance, structure, preparation, properties, and reactions of three, four, five, and six membered heterocyclic compounds (including furan, pyrrole, thiophene, pyridine, indole, and their derivatives). Aromatic heterocycles, Polyhetero ring systems, modern methods in heterocycle synthesis, Chemistry of natural products: Terpenes, steroids, alkaloids, and pigments: Flavones, xanthones, quinones, pterins, chlorophyll, carotenoids, chemistry of vitamins, carbohydrates, fatty acids, and nucleic acids
4	**Texts/References**	1. I. L. Finar, *Organic Chemistry, Vol .2*, 5th edition, ELBS, 1975. 2. K. Nakanishi, T. Goto, S.Ito, S. Najori and S. Nozoe, *Natural products Chemistry*, *Vol. 1 and 2*, Academic Press, 1974. 3. Topics in Heterocycles Chemistry. G. W. Gribble. Spinger-Verlag Berlin Heidelberg, 2010. 4. Handbook of Heterocyclic Chemistry. Alan R. Katritzky and A. F. Pozharskii, Elservier 2000. 5. The Chemistry of Heterocycles. T. Eicher, S. Hauptmann, Wiley-VCH 2003 6. R. K. Bansal, Heterocyclic Chemistry, Synthesis, Reactions and Mechanisms, Wiley Eastern Ltd., 1990.

1	**Title of the course** (L-T-P-C)	**Advanced organic synthesis** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101), Organic reactions and reagents, concepts in organic synthesis
3	**Course content**	Reaction vs synthetic method; metal atom functionality in organometallic reactions, C-C bond forming reactions, ring forming reactions, organometallics as protecting and stabilizing groups, palladium catalyzed reactions, Heck reaction, cross coupling reactions (Suzuki, Stille, Negishi, Kumada, Hiyama, Sonogashira, Buchwald-Hartwig), Olefin metathesis, NHCs and application to organic synthesis, Role of silicon in organic synthesis, Target and diversity oriented synthesis, Asymmetric synthesis, Chiral and Organocatalysis, Some selected natural and non-natural product total synthesis, Introduction to domino/tandem/cascade reaction concepts
4	**Texts/References**	1. G. S. Zweifel and M. H. Nantz, Modern Organic Synthesis-An Introduction, W. H. Freeman and Company, 2006 2. B. M. Trost and I Fleming, Comprehensive organic synthesis, Pergamon Press, 1992. 3. S. Warren, "*Designing Organic Syntheses"*, John Wiley & Sons **2009.** 4. K. C. Nicolaou, E. J. Sorenson, "*Classics in Total Synthesis, I, II and III"* 5. T.W. Greene, "*Protecting Groups in Organic Synthesis"* (3rd edition), J. Wiley & Sons, **1999**. 6. F. A. Carey, R. Sundberg, , "*Advanced Organic Chemistry, Part B*", 2nd Ed., Plenum Press, **1990**. 7. E. J. Corey, X. Cheng, "*The Logic of Chemical Synthesis"*, John Wiley **1989**. 8. David J. Hart "Organic *Synthesis via Examination of Selected Natural Products*" World Scientific, **2011**

1	**Title of the course** (L-T-P-C)	**Advanced Inorganic Chemistry** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Main group chemistry and Transition metals and coordination chemistry
3	**Course content**	Main-group chemistry: Inorganic polymers: Borazines-, heterocyclophosphazenes-, siloxanes-, stannoxanes-derived polymers, sulfur-nitrogen polymers, phosphorus-nitrogen polymers, polysilane, poly-silazane, B-N polymers, precursors for ceramics and applications. Transition metal chemistry: Electronic spectra and magnetism of transition metal coordination complexes. New trends in transition metal coordination chemistry: Photochemistry and photophysics of transition metal complexes. Water splitting reaction using coordination compounds. Metalo-supramolecular chemistry, inorganic fluorescent compounds and their applications.
4	**Texts/References**	1. Stochel, G., et al., Bioinorganic Photochemistry, Wiley, 2009. 2. Lippard, S. J. and Berg, J. M., Bioinorganic Chemistry, University Science Books, 1994. 3. Huheey, J. E., et al., Inorganic Chemistry-Principles of Structure and Reactivity, 4th Ed., Harper-Collins, 1993. 4. Greenwood, N. N., and Earnshaw, A., Chemistry of the Elements, 1st Ed., Pergamon, Oxford, 1989. 5. Elschenbroich, C., Organometallics, 3rd Ed., Wiley-VCH, 2006. 6. Journal articles

1	**Title of the course** (L-T-P-C)	**Organic chemistry of enzymes and biosynthesis (3-0-0-3)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101), Bioorganic chemistry
3	**Course content**	Enzyme structure and kinetics, Cofactors in biological chemistry (thiamine, flavin, pterin, biotin, NAD/NADH, ATP, heme, cobalamin), Organic reactions in biological pathways: Group Transfer Reactions: Hydrolysis, Amination, Phosphorylation, reduction and oxidation, oxygenation, substitutions, carboxylation and decarboxylation, Isomerization, Eliminations and additions, Aldol and Claisen reactions, formylations and methylations, Rearrangements, and pericyclic reactions, Natural product biosynthesis: Strategies and examples, chemo-enzymatic synthesis
4	**Texts/References**	1. R. Silverman, "The organic chemistry of enzyme catalyzed reactions" Revised ed., Academic Press, 2002. 2. D. Vranken and G.A. Weiss "Introduction to Bioorganic Chemistry and Chemical Biology" 1st Ed., Garland Science, 2012. 3. McMurry and Begley "The Organic Chemistry of Biological Pathways" 2nd ed., WH Freeman, 2015 4. Nelson and Cox, "Lehninger Principles of Biochemistry", 7th Ed., WH Freeman, 2017 5. P. Frey and A. D. Hegeman, "Enzymatic Reaction Mechanisms", 1st Ed., OUP USA, 2007. 6. P. Bruice, "Organic Chemistry" 7th Ed., Pearson, 2013. 7. Walsh and Tang, "Natural Product Biosynthesis: Chemical Logic and Enzymatic Machinery" Royal Society of Chemistry; 1st edition (28 April 2017)

1	**Title of the course** (L-T-P-C)	**Quantum Chemistry** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101) and Chemical Bonding and symmetry
3	**Course content**	Matrix formulation of quantum mechanics: transformation, representations, projection operators, equations of motion. Operator formalism: Virial theorem, normal operators, Dirac's method of solution of harmonic oscillator problem. Angular momentum: ladder operator technique, solutions, differential equation methods, spin, addition of angular momenta. Explicit derivation of Hartree and Hartree-Fock equations, Roothaan equations, basis sets - STO and GTO, calculation of integrals, semiempirical methods. Configuration interaction. Tunnel effect: square barrier, WKB approximation, electron and proton transfer. Many-body treatments: correlation energy, N-dependence, diagrammatic representations and linked cluster theorem.
4	**Texts/References**	• D. A. McQuarrie, Quantum Chemistry, Viva Books Private Ltd. 2000 • I. R. Levine, Quantum Chemistry, Prentice Hall India (Ltd.), 1995. • A. Szabo and N. S. Ostlund, Modern Quantum Chemistry, McGraw-Hill, 1989. J.

1	**Title of the course** (L-T-P-C)	**Statistical Mechanics** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Ensembles and Averages, equivalence of Ensembles, classical Limit. Monte Carlo and Molecular Dyamics simulations. Distribution functions at equilibrium. Integral equation methods. Perturbation theory. Density functional methods. Molecular fluids. Estimation of thermodynamic functions. Non-equilibrium methods. Linear response theory. Stochastic processes and Brownian motion. Selected applications to problems in chemical dynamics, relaxation processes and neutron diffraction
4	**Texts/References**	• D. A. McQuarrie, *Statistical Mechanics*, Harper and Row,1974. • M. P.Allen and D. J. Tildesley, *Computer Simulation in Liquids*, Oxford University Press, 1987. • J. P. Hansen and I. R. McDonald, *Theory of Liquids*, 2nd edition, Academic Press,1986. • D. Chandler, *Statistical Mechanics*, Oxford University Press, 1985. • H. L. Friedman, *A Course in Statistical Mechanics*, Prentice Hall,1983.

1	**Title of the course** (L-T-P-C)	**Organometallics and organometallic reagents (3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	•History and types of Organometallic compounds, 18 Valence Electron Rule and Classification. •Sigma-Donor ligands: Preparation and Properties and its application. •C−H activation, characterization and bonding. C−C Bond activation, Transition Metal Perfluoroalkyl (RF−TM) Complexes and its preparation. C−F Activation •Transition Metal Alkenyl/Aryl/Alkyne/Carbene/carbynes Complexes •Transition Metal Carbonyls: Bonding properties, Reactivity, Carbonyl Metallates, Carbonyl Hydrides and its application, application of Metal Halides and Metal Alkenes •Transition Metal Olefin Complexes: Reactivity, Bonding Properties. •Transition Alkyne Complexes: Reactivity. • Organometallic reagents
4	**Texts/References**	1. Organometallics by Christoph Elschenbroich 2. Organometallic Chemistry of Transition Metals by Robert H Crabtree.

1	**Title of the course** (L-T-P-C)	**Coordination chemistry, Organometallics and organometallic reagents (3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	• Coordination chemistry: Fundamentals, theory and applications. • History and types of Organometallic compounds, 18 Valence Electron Rule and Classification. •Sigma-Donor ligands: Preparation and Properties and its application. •C−H activation, characterization and bonding. C−C Bond activation, Transition Metal Perfluoroalkyl (RF−TM) Complexes and its preparation. C−F Activation •Transition Metal Alkenyl/Aryl/Alkyne/Carbene/carbynes Complexes •Transition Metal Carbonyls: Bonding properties, Reactivity, Carbonyl Metallates, Carbonyl Hydrides and its application, application of Metal Halides and Metal Alkenes •Transition Metal Olefin Complexes: Reactivity, Bonding Properties. •Transition Alkyne Complexes: Reactivity.
4	**Texts/References**	Organometallics by Christoph Elschenbroich Organometallic Chemistry of Transition Metals by Robert H Crabtree.

1	**Title of the course** (L-T-P-C)	**Organic spectroscopy (3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Infrared spectroscopy • Mass spectrometry • nuclear magnetic resonance spectroscopy
4	**Texts/References**	Organic spectroscopy by William Kemp

1	**Title of the course** (L-T-P-C)	**Interpretative NMR spectroscopy and mass spectrometry (3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	**NMR spectroscopy:** Basic principles of ^{1}H-NMR, instrumentation and interpretation of NMR spectrum, chemical shift: principles, chemical shift values of major organic compound classes, and factors affecting chemical shift**,** spin-spin coupling, spin systems, coupling with other nuclei, 2D-NMR (COSY, TOCSY), NOE (NOESY)**,** ^{13}C-NMR-principles and chemical shifts for major organic compound classes**,** ^{1}H-^{13}C-2D NMR (HSQC, HMBC), DEPT, ^{31}P and ^{19}F-NMR and applications of NMR in chemistry and biology. **Mass Spectrometry:** Instrumentation and techniques (ionization techniques, mass analysers, and detection techniques, tandem MS or MS/MS, LC-MS, GC-MS, MALDI-TOF-MS etc.)**,** interpretation of mass spectra**,** fragmentation patterns of major organic compound classes including rearrangement reactions and applications of mass spectrometry in chemistry and biology**.**
4	**Texts/References**	1. R. Silverstein, F. Webster, D. Kiemle, and D. Bryce "Spectrometric identification of organic compounds", 8th Ed., Wiley, 2015. 2. P. Crews, J. Rodriguez, and M. Jaspars, "Organic structure analysis", 2nd Ed., OUP USA, 2009. 3. D. Williams and I. Fleming, "Spectroscopic methods in organic chemistry", 6th Ed., McGraw Hill Education, 2011. 4. W. Kemp, "Organic spectroscopy", 2nd Ed., Red Globe Press, 2019. 5. D. Pavia "Introduction to spectroscopy" Cengage Learning India Private Ltd., 5th Ed., 2015. 6. C. Banwell and E. McCash "Fundamentals of molecular spectroscopy" 4th Ed., McGraw Hill Education, 2017. 7. J. Keeler "Understanding NMR spectroscopy" 2nd Ed., Wiley, 2011. 8. K. Chary and G. Govil "NMR in biological systems: from molecules to human" 1st Ed., Springer, 2008.

1	**Title of the course** (L-T-P-C)	**Advanced computational chemistry** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Introduction to computer programming in Fortran, Elementary programming methods, arrays, do loops, functions and subroutines. Elementary numerical methods, error analysis, interpolations, matrix methods, integration, differential equations, integral transforms and random numbers. Use of Scilab in numerical methods and graphics. Classical molecular dynamics and Monte Carlo Simulations. Use of Gromacs software for classical molecular dynamics
4	**Texts/References**	T. R. McCalla, Introduction to Numerical Methods and Fortran Programming (1967), Amazon Books M. P. Allen and D. J. Tildesley, Computer Simulation of Liquids, Oxford University Press (1990) NPTEL/MOOCS videos and course materials on Computational Chemistry Gromacs manual

1	**Title of the course** (L-T-P-C)	**Analysis of optical and electronic properties of π-conjugated compounds and pertinent applications (3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Principles of photochemistry and electrochemistry • Optical and electronic properties of polycyclic aromatic compounds; Organic one-dimensional (1D) and 2D polymers and Metal based π- conjugated compounds • Applications of π-conjugated compounds
4	**Texts/References**	1. Organic optoelectronic materials (lecture notes in Chemistry) 2015th edition by Yongfang Li 2. Photochemistry of organic compounds: from concepts to practice (first edition) by Petr Klan and Jakob Wirz

1	**Title of the course** (L-T-P-C)	**Bioorganic chemistry and Chemical Biology (3-0-0-3)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	Aminoacids, peptides and proteins: physicochemical properties and chemical synthesis; peptide bond formation, amino acid analysis and peptide sequencing; brief introduction to ribosomal protein synthesis; combinatorial chemistry; enzyme chemistry; proteins as drug targets. Carbohydrates: Introduction; structure, configuration, and conformation; common protecting groups and protecting group strategies; glycosylation: general concepts, various methods of glycoside bond formation; strategies in oligosaccharide synthesis: carbohydrate-based drug discovery. Nucleic acids: Introduction, structure, chemical and enzymatic synthesis, DNA, RNA polymerases, ligases, restriction enzymes, PCR and sequencing, nucleic acid as drug targets, ribozymes, DNA enzymes and riboswitches; antisense, RNA interference and aptamers; DNA damage and repair. Structure, function, physicochemical properties of lipids and fatty acids Biological chemistry and principles of chemical biology, Chemistry of biological pathways, role of chemistry in understanding biology
4	**Texts/References**	1. P. Lloyd-Williams, F. Albericio, E. Giralt, Chemical Approaches to the Synthesis of Peptides and Proteins, 1st Edition, CRC Press, Boca Raton,1997 2. S. Doonan, Peptides and Proteins, 1st Edition, RSC Publishing House, London, 2002 3. T. Bugg, An Introduction to Enzyme and Coenzyme Chemistry, 2nd Edition, Blackwell Science, Oxford, 2004 4. B. G. Davis & A.J. Farbanks, Carbohydrate Chemistry, 1st Edition, Oxford University Press, 2002 5. R. V. Stick., Carbohydrates: The Essential Molecules of Life, 2nd Edition, Academic Press, 2009 6. D. E. Levy and P. Fugedi, The Organic Chemistry of Sugars, CRC Press, 2006 7. G. M. Blackburn, M. J. Gait, D. Loakes, D. M. Williams, Nucleic Acids in Chemistry and Biology, 3rd Edition, RSC Publishing, London, 2006 8. S. Doonan, Nucleic Acids, 1st Edition, RSC Publishing House, London, 2000 9. 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)	**Fundamentals and Applications of Organic Photochemistry (3-0-0-6)**
2	**Pre-requisite courses(s)**	NIL
3	**Course content**	Principles of photochemistry • Resonance energy transfer (RET), Fluorescence resonance energy transfer (FRET), excited state intra-molecular proton transfer (ESIPT) mechanisms • Solid state optical properties: aggregation induced enhanced emissions • Optical and electronic properties of polycyclic aromatic compounds • metal-organic based p-conjugated molecules • Organic one-dimensional (1D) and 2D polymers and Metal based π-conjugated compounds • Electronic properties of p-conjugated compounds: fundamentals of electrochemical techniques • HOMO and LUMO and band gap evaluations • spectroelectrochemistry • Electrochemical sensors • Applications of π-conjugated compounds for optoelectronic applications: OLEDS, solar cells, OLETs etc.
4	**Texts/References**	1. Petr Klan and Jakob Wirz "Photochemistry of organic compounds: from concepts to practice (postgraduate chemistry series)", 1st Ed., Wiley-Blackwell, 2009. 2. N. J. Turro, V. Ramamurthy, J. C. Scaiano "Modern Molecular Photochemistry for Organic Molecules" 1st Ed.' Viva books, 2017. 3. Yongfang Li (editor) "Organic optoelectronic materials (lecture notes in chemistry)" 1st Ed., Springer, 2015. 4. K. K. Rohtagi-Mukhejee "Fundamentals of photochemistry", 3rd Ed., New age international publishers, 2017. 5. J. R. Lakowicz "Principles of Fluorescence Spectroscopy", 2nd Ed., Springer, 1999.

1	**Title of the course** (L-T-P-C)	**Molecular spectroscopy** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	NIL
3	**Course content**	NMR spectroscopy: Basic principles of ^{1}H-NMR, instrumentation and interpretation of NMR spectrum, chemical shift: principles, chemical shift values of major organic compound classes, and factors affecting chemical shift, spin-spin coupling, spin systems, coupling with other nuclei, 2D-NMR (COSY, TOCSY), NOE (NOESY), ^{13}C-NMR-principles and chemical shifts for major organic compound classes, ^{1}H-^{13}C-2D NMR (HSQC, HMBC), DEPT, ^{31}P and ^{19}F-NMR and applications of NMR in chemistry and biology. Mass Spectrometry: Instrumentation and techniques (ionization techniques, mass analysers, and detection techniques, tandem MS or MS/MS, LC-MS, GC- MS, MALDI-TOF-MS etc.), interpretation of mass spectra, fragmentation patterns of major organic compound classes including rearrangement reactions and applications of mass spectrometry in chemistry and biology.
4	**Texts/References**	1. R. Silverstein, F. Webster, D. Kiemle, and D. Bryce "Spectrometric identification of organic compounds", 8th Ed., Wiley, 2015. 2. P. Crews, J. Rodriguez, and M. Jaspars, "Organic structure analysis", 2nd Ed., OUP USA, 2009. 3. D. Williams and I. Fleming, "Spectroscopic methods in organic chemistry", 6th Ed., McGraw Hill Education, 2011. 4. W. Kemp, "Organic spectroscopy", 2nd Ed., Red Globe Press, 2019. 5. D. Pavia "Introduction to spectroscopy" Cengage Learning India Private Ltd., 5th Ed., 2015. 6. C. Banwell and E. McCash "Fundamentals of molecular spectroscopy" 4th Ed., McGraw Hill Education, 2017. 7. K. Chary and G. Govil "NMR in biological systems: from molecules to human" 1st Ed., Springer, 2008.

1	**Title of the course** (L-T-P-C)	**Optical and electronic properties of π-conjugated compounds (3-0-0-6)**
2	**Pre-requisite courses(s)**	NIL
3	**Course content**	Principles of photochemistry and electrochemistry• Optical and electronic properties of polycyclic aromatic compounds; Organic one-dimensional (1D) and 2D polymers and Metal based π-conjugated compounds• Applications of π-conjugated compounds; Principles of photochemistry • Resonance energy transfer (RET), Fluorescence resonance energy transfer (FRET), excited-state intramolecular proton transfer (ESIPT) mechanisms • Solid-state optical properties: aggregation-induced enhanced emissions • Optical and electronic properties of polycyclic aromatic compounds • metal-organic based p-conjugated molecules • Organic one-dimensional (1D) and 2D polymers and Metal-based π-conjugated compounds • Electronic properties of p-conjugated compounds: fundamentals of electrochemical techniques • HOMO and LUMO and band gap evaluations • spectroelectrochemistry • Electrochemical sensors • Applications of π-conjugated compounds for optoelectronic applications: OLEDs, solar cells, OLETs, etc.
4	**Texts/References**	1. Organic optoelectronic materials (lecture notes in Chemistry) 2015th edition by Yongfang Li 2. Photochemistry of organic compounds: from concepts to practice (first edition) by Petr Klan and JakobWirz

1	**Title of the course** (L-T-P-C)	**Topics in Chemistry** **(3-0-1-8)**
2	**Pre-requisite courses(s)**	NIL
3	**Course content**	**Organic and Inorganic: Chemistry of Materials** • Introduction to materials, Periodic table, its physical and chemical properties of elements, Introduction to solid state chemistry -1&2, Carbon chemistry – physical and chemical properties, Bulk to nano transition - physical phenomena, 3D, 2D, 1D, OD nano systems, Introduction to nanoscience and nanotechnology - Metals, semiconductors, Introduction to nanoscience and nanotechnology - Carbon nanotubes, fullerenes, Quantum dots. • Systems under technological importance - Naturally occurring materials, Optical and magnetic systems based on metals, • Inorganic semiconductors - optical materials, magnetic materials • Organic semiconductors -optoelectronic materials, optoelectronic materials Self-assemblies of nanoparticles, Nano systems - catalysis, Surface coating technology, High temperature superconductivity, Application of high temperature superconductivity, Complex metal oxide, Giant magneto resistance, Spintronic. •Chemical and non-chemical approach to materials synthesis - Solution based material synthesis - Precipitation methods, hydrothermal etc., Solution based materials synthesis - Micro- emulsion, Sol-gel, Phase transfer reactions, Synthesis and properties of monolayer capped metal nanoparticles, Material synthesis using microwave radiation and ultra-sonic waves, Solid state synthesis, Hybrid methods for materials synthesis - synthesis of rational shaped molecules and semiconductors. •Modern Characterization of materials (SEM, TEM, XPS, AFM, powder X-ray etc., Routine characterization tools-UV-visible spectrophotometer, Fluorimeter, NMR, IR, Particle size analyzer, Powder X-ray microscopy). **Physical: Ab Initio Molecular Orbital Theory** SCF and HartreeFock Methods, Roothan Equations, Configuration Interaction, Density Functional Theory, Perturbation theory and applications.
4	**Texts/References**	J. D. Lee, Concise Inorganic Chemistry, Fifth edition, Blackwell publishing (2008) Robert T. Morrison, Robert N. Boyd, and Robert K. Boyd, Organic Chemistry, 6th edition Benjamin Cummings, (1992) Charles P. Poole Jr. Frank J. Owens, Introduction to Nanotechnology, John Wiley & Sons, Inc. (2003) Nan Yao, Zong Lin Wang, Handbook of Microscopy for Nanotechnology, Kluwer academic publishers, London (2005) Pople, J.A. and Beveridge, D.L. Approximate Molecular Orbital Theory. McGraw-Hill, New York. (1970) Ab Initio Molecular Orbital Theory by W. J. Hehre, L. Radom, P. v. R. Schleyer, and J. A. Pople, John Wiley, New York, 548, (1986) Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory, by Attila Szabo, Neil S. Ostlund, Dover Publications, New York (2000) Introductory Quantum Chemistry/Quantum Mechanics Books by authors such as Pilar, McQuarrie, Pauling and Wilson, NPTEL Web and Video courses in quantum chemistry and computational chemistry

1	**Title of the course** (L-T-P-C)	**Molecular Spectroscopy** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	
3	**Course content**	Introduction to spectral energy domains and measurement of spectra, Implications of discrete energy levels, Population of States – Boltzmann Distribution, Interaction of radiation with matter, origin of linewidths in molecular spectra, Transition dipole moment and Fermi's Golden Rule, Einstein's Coefficients, Lasers and Masers. Rotational (Microwave) spectroscopy, Molecular vibrations - Infrared spectroscopy, Normal mode analysis, Raman Scattering, Selection Rules from Group Theory, Molecular electronic spectra, Photophysical processes, Non-Linear Spectroscopy, Nuclear Magnetic Resonance, Relaxation times, FT-NMR, spin-spin coupling, ESR, Nuclear Quadrupolar Resonance.
4	**Texts/References**	1. J. L. McHale, Molecular Spectroscopy, Pearson Education, 2008 2. M. Hollas, Modern Spectroscopy, Wiley; 4th edition, 2004. 3. F. A. Cotton, Chemical Applications of Group Theory, An Indian Adaptation, Wiley-Interscience, 2020. 4. C. M. Banwell, E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edition Tata McGraw Hill, 2017 5. G. M. Barrow, Introduction to Molecular Spectroscopy, Hassle street press, 2021 6. J. I. Steinfeld, Molecules and Radiation: An Introduction to Modern Molecular Spectroscopy, 2nd edition, Dover, 2012. 7. J. D. Graybeal, Molecular Spectroscopy, McGraw Hill 2014. 8. D. A. McQuarrie and J. D. Simon, Physical Chemistry - a molecular approach, Viva Books Pvt. Ltd. 2019.

1	**Title of the course** (L-T-P-C)	**Organic reactions and mechanisms** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	NIL
3	**Course content**	Reactive Intermediates**:** An overview and revision of the chemistry of carbenes, nitrenes, radicals, carbocations, carbanions and benzynes. Classification of reactions: A brief introduction to substitution, elimination, addition, oxidation, reduction, rearrangement and pericyclic reactions. Named reactions, mechanisms and applications: Aldol reaction, alkene and alkyne metathesis, Baeyer-Villiger oxidation, Barton reaction, Beckmann rearrangement, benzilic acid rearrangement, benzoin and acyloin condensation, Bergman cycloaromatization reaction, Birch reduction, Brown hydroboration, Buchner reaction, Buchwald-Hartwig cross- coupling, Burgess dehydration, Cannizzaro reaction, Claisen condensation, Claisen rearrangement (including Johnson, Ireland and Eschenmoser modifications), Cope reaction, Cope rearrangement (including aza-Cope and oxy Cope), Corey and related reactions, Criegee oxidation, Curtius rearrangement, Dakin oxidation, Darzens condensation, Danishefsky's diene cycloaddition, Dess-Martin oxidation, Dieckmann condensation, Diels-Alder cycloaddition, Ene reaction, Eschenmoser-Tanabe Fragmentation, Favorskii rearrangement, Fischer indole synthesis, Friedel- Crafts reaction, Fries rearrangement, Gabriel synthesis, Grignard reaction, Heck reaction, HVZ reaction, Hoffmann reaction and elimination, Hoffman rearrangement, Jacobsen epoxidation, Jones oxidation, Julia olefination, Knoevenagel condensation, Kolbe-Schmitt reaction, Lossen rearrangement, Mannich reaction, McMurry coupling, MPV reduction, Michael addition, Mitsunobu reaction, Negishi cross coupling, Oppenauer oxidation, Paterno-Buchi reaction, Perkin reaction, Peterson olefination, Pictet-Spengler reaction, Pinacol rearrangement, Prevost reaction, Pummerer rearrangement, Reformatsky reaction, Reimer-Tiemann reaction, Robinson annulation, Schmidt reaction, Sandmeyer reaction, Sharpless epoxidation and dihydroxylation, Shapiro reaction, Smiles rearrangement, Sonogashira cross-coupling, Staundinger reaction, Stevens rearrangement, Stille coupling, Stobbe condensation, Strecker reaction, Suzuki cross-coupling, Swern oxidation, Tebbe olefination, Tsuji-Trost reaction, Ugi reaction, Ullmann reaction, Wacker oxidation, Wagner- Meerwein rearrangement, Williamson ether synthesis, Wolff rearrangement, Wollf-Kishner reduction, Wurtz coupling, Witting reaction and Wittig rearrangement
4	**Texts/References**	1.Jerry March and Michael Smith, "Advanced Organic Chemistry", 7th Ed., Wiley. 2.F. A. Carey and R. J. Sundburg, "Advanced Organic Chemistry, Part A and B", Fifth Ed., Plenum Press. 3. J. Clayden, N. Greeves, S. Warren and P. Wothers, "Organic Chemistry", 2nd Ed., Oxford University Press. 4.W. Carruthers, "Some Methods of Organic Synthesis", Cambridge University Press. 5.Laszlo Kurti and Barbara Czako, "Strategic applications of named reactions in organic synthesis" 6.Norman and Coxon, "Principles of organic synthesis, 3rd edition, CRC press 7.Robert Grossman, "Art of writing reasonable organic reaction mechanisms", 2nd edition 8.Organic chemistry by Paula Bruice/ Wade Jr/Solomons

1	**Title of the course** (L-T-P-C)	**Transition Metals and Coordination Chemistry (3-0-0-6)**
2	**Pre-requisite courses(s)**	
3	**Course content**	1.Chemistry of transition metals: Introductory survey of transition elements with reference to electronic configuration, oxidation states, complex compounds. Introductory concepts of molecular symmetry. Spectral and magnetic properties. 2. Chemistry of titanium, vanadium, chromium, manganese sub-group elements, iron, cobalt, nickel, platinum metals, copper and zinc sub-group elements, group III, IV, V, VI, VII and rare gases with reference to isolation, properties, uses and important compounds. 3. Chemistry of Lanthanides and Actinides: Electronic configuration, colour and magnetism, properties of lanthanides and actinides. Synthesis of trans-Uranic elements, chemistry of uranium compounds. 4. Introduction to Coordination Compounds: Werner's work, structure, isomerism, thermodynamics of complex formation. 5. Bonding in Transition Metal Complexes: Valence bond theory, crystal field theory, ligand field theory, pi-acceptor/donor interactions. 6. Electronic Spectra: Energy levels in an atom, coupling of orbital angular momenta, spin angular momenta, and spin-orbit, ground state terms-Hund's rules, microstates, electronic spectra (selection rules), splitting of electronic energy levels and spectroscopic states, Tanabe-Sugano diagrams. 7. Reactions and Mechanism: Ligand substitution reactions, base hydrolysis, stereochemistry, isomerization reactions, redox reactions (the inner-sphere mechanism, the outer- sphere mechanism), photochemical reactions.
4	**Texts/References**	1. Concise Inorganic Chemistry by J. D. Lee, 5th edition, Blackwell Publishing, 2006. 2. Inorganic Chemistry by Gary L. Miessler, Paul J. Fischer, and Donald A. Tarr,5th edition, 2014. 3. Catherine E. Housecroft and Alan G. Sharpe, Inorganic Chemistry, 5th edition., 2018. 4. Atkins, P., et al., Shriver and Atkins Inorganic Chemistry, 5th Ed., Oxford UniversityPress, 2010. 5. Organometallics by Christoph Elschenbroich, 3rd edition, 2006. 6. The Organometallic Chemistry of the Transition Metals by Robert H Crabtree, 2014. 7. J. E. Huheey, E. A. Keiter, and R. L. Keiter, Inorganic Chemistry – Principles of Structure and Reactivity, 4th Ed, Pearson Education, 2006. 7.Advanced Inorganic Chemistry by F. A. Cotton, G. Wilkinson C. A. Murillo and M. Bochmann, John Wiley,Chichester, 6th edition, 1999.

1	**Title of the course** (L-T-P-C)	**Advanced Quantum Chemistry** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Brief review of Quantum chemistry, Schrödinger equation for multielectron systems, Approximation methods in Quantum mechanics, Variational methods and time-independent Perturbation theory, Atomic term symbol Born-Oppenheimer approximation, Valence bond and Molecular orbital methods, H_2^+ ion, Slater determinant, Derivation of Hartree-Fock Methods, Roothaan Equation, Population Analysis, Electron correlation, Configuration interactions, Huckel theory for pi-systems, Density functional theory
4	**Texts/References**	1. Quantum Chemistry by Donald A. McQuarrie, 2nd Edition 2008, University Science Books 2. Quantum Chemistry by I. N. Levine, 7th Edition, Pearson Education, 2000 3. Modern Quantum Chemistry: Introduction to advanced electronic structure theory, by Attila Szabo and Neil S. Ostlund, MacMillan Publishing Co. 1989 4. A Chemist's Guide to Density Functional Theory by Wolfram Koch, Max C. Holthausen, 2nd Edition 2001, Wiley-VCH and John Wiley & Sons, Weinheim

1	**Title of the course** (L-T-P-C)	**Green Chemistry** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Introduction and metrices of green chemistry, Principles of green chemistry, Designing a sustainable synthesis, Bioremediation, Use of benign solvents in synthesis, Applications of green chemistry in real world, Renewable feedstock, Recycling of materials and chemicals, Toxic chemicals in environment, Green materials synthesis, New Green and sustainable synthetic methods, Society reliant chemicals, Bio catalysis, Green analytical methods, Alternate energy sources, Challenges and Future trends in Green chemistry.
4	**Texts/References**	1. Anne E. Marteel-Parrish and Martin A. Abraham, Green Chemistry and Engineering: A pathway to sustainability. Wiley, 2014. 2. Manahan, S. E. Environmental Chemistry, Eighth Edition; CRC Press, 2005 3. Sankar, D; Nayim, S. A textbook of Green Chemistry, 2021, 4. Anastas, P.T. & Warner, J.K.: Green Chemistry - Theory and Practical, Oxford University Press (1998). 5. Lancaster, M. Green Chemistry: An Introductory Text, Third Edition; RSC Publishing; 2016. 6. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001). 7. Ryan, M.A. & Tinnesand, M. Introduction to Green Chemistry, American Chemical Society, Washington (2002). 8. Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, 2nd Edition, 2010.

1	**Title of the course** (L-T-P-C)	**Concepts and Mechanisms in Organic Chemistry** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	
3	**Course content**	Basic mechanistic concepts – kinetic versus thermodynamic control, Hammond's postulate and Curtin-Hammett principle. Methods of determining reaction mechanisms through kinetics, identification of products, intermediates and isotopic labeling. Linear free-energy relationship – Hammett and Taft equations. Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction. Geometrical isomerism and optical isomerism. Atropisomerism, and neighboring group participation on reactivity and selectivity. Reactive Intermediates: Generation, structure, properties and reactions of carbenes, nitrenes, radicals, carbocations, carbanions and benzynes. Introduction to different reaction types:substitution, elimination, addition, oxidation, reduction, pericyclic and concerted reactions (electrocyclic, cycloaddition and sigma tropic) and molecular rearrangements
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", 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. P. Bruice, "Organic Chemistry" 7th Ed., Pearson, 2013.

1	**Title of the course** (L-T-P-C)	**Inorganic Chemistry in Biology** **3-0-0-6**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	1. Introduction: the metals and biological ligands. 2. Electron transfer process: iron-sulfur enzymes, blue-copper protein, mcytochrome. 3. Dioxygen (O2) transport: haemoglobin, myoglobin, haemocyanin, Haemerythrin. 4. Key small molecule transformation: - 4.1 O2 and H2O2 utilization by enzymes: catalytic cycle of cytochrome P450, metal, ligand coordination, and reaction in active site of cyt c oxidase, MMO, LPMO, tyrosinase, rieske dioxygenase, oxidase, peroxygenase, and peroxidase enzymes. 4.2 N2 cycle: Active site of nitrogenase, nitrogenation, nitrification, denitrification process. 4.3 Hydrogenase (H2ß>H+) 4.4 Photosystem II (H2O oxidation) 4.5 Carbon monoxide dehydrogenase 5. Radicals in nature: reactive oxygen species (ROS), superoxide dismutase, reactive nitrogen species (RNS), cobalamine, radical S- adenosyl methionine (rSAM) enzyme, cupper radical oxidase. 6. Acid-base catalysis: carbonic anhydrase, alkaline phosphatase. 7. Artificial metalloenzymes (ArM): redesigning natural metalloenzymes, examples of reactions by ArM, new-to-nature reactions.
4	**Texts/References**	1. Atkins, P., et al., Shriver and Atkins Inorganic Chemistry, 6th Ed., Oxford UniversityPress, 2014. 2. BIOLOGICAL INORGANIC CHEMISTRY: STRUCTURE & REACTIVITY; Bertini, Gray, Stiefel, Valentine., 2007 3. BIOINORGANIC CHEMISTRY: INORGANIC ELEMENST IN THE CHEMISTRY OF LIFE; Kaim, Schwederski, Klein. 2nd edition, 2013 4. CATHERINE E. HOUSECROFT AND ALAN G. SHARPE, Inorganic Chemistry, 5th Ed. 2018. 5. Activation of Small Molecules: Organometallic and Bioinorganic Perspectives. Edited by Prof. William B. Tolman, 2006. 6. Principles Of Bioinorganic Chemistry by Jeremy Berg and Stephen J. Lippard, 1994.

1	**Title of the course** (L-T-P-C)	**Symmetry and Group theory** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Introduction to chemical bonding, Symmetry elements and operations, Schönflies notation of point group, Prediction of dipole moment and optical activity from the viewpoint of symmetry, Definition of group, subgroup, class, Matrix representation of a point group Reducible & Irreducible representations, Great Orthogonality Theorem and its corollaries, Construction of character table and meaning of all the term in character table, Mulliken symbol for irreducible representation, Direct product of irreducible representations, Application to spectroscopy, Projection operator and its application to symmetry adapted linear combination (SALC), Application to quantum mechanics, Construction of Molecular Orbital correlation diagram of simple and complex molecule
4	**Texts/References**	• F. A. Cotton, Chemical Applications of Group Theory, An Indian Adaptation, Wiley-Interscience, 2020. • R. L. Carter, Molecular symmetry & group theory, John Wiley & Sons, 1997 • D. C. Harris, M. D. Bertolucci, Symmetry and Spectroscopy, Dover, 1989. • Michael Tinkham Group Theory and Quantum Mechanics, Dover publications, 2003

1	**Title of the course** (L-T-P-C)	**Main group chemistry** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• 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. • Hydrogen and hydrides, the boron and carbon groups, the nitrogen and oxygen groups, the halogens and the noble gases. • Review of inorganic chains, rings and cages, Inorganic chains, rings, and cages. • Nuclear magnetic resonance (NMR) and Electron paramagnetic resonance (EPR) spectroscopy of Inorganic System • Mössbauer spectroscopy • Vibrational spectroscopy: Fourier transform infrared (FT- IR) and Raman spectroscopy, resonance Raman spectroscopy • UV-vis, X-ray absorption spectroscopy (XAS)
4	**Texts/References**	• Atkins, P., et al., Shriver and Atkins Inorganic Chemistry, 5th edition, Oxford University Press, 2010. • Lee, J. D., Concise Inorganic Chemistry, 5th edition, Blackwell Publishing, 2006. • Douglas, B., McDaniel, D., Alexander, J., Concepts and Models of Inorganic Chemistry, 3rd Ed. Wiley India (P.) Ltd., India, 2010. • J. E. Huheey, E. A. Keiter, and R. L. Keiter, Inorganic Chemistry – Principles of Structure and Reactivity, 4th edition, Pearson Education, 2006. • Chemistry of the Elements, by N.N. Greenwood and A. Earnshaw, Butterworth-Heinmann, London, 1997. • Advanced Inorganic Chemistry by F. A. Cotton, G. Wilkinson C. A. Murillo and M. Bochmann, John Wiley, Chichester, 1999.

1	**Title of the course** (L-T-P-C)	**Chemistry laboratory I** **0-0-3-3**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Inorganic chemistry: Basic concepts of quantitative analysis, redox, precipitation and complexometric titrations. Solubility product and precipitation, organic precipitants and extractants. A brief survey of separation methods: solvent extraction and chromatography. Volumetric analysis involving redox, precipitation and complexometric titrations. Organic chemistry: Determination of physical constants, purification of solids and liquids and methods of checking their purity. Separation of enantiomers and measurements of optical rotation. Studies of electrophilic/nucleophilic substitution reactions, redox reactions Physical chemistry:Ionization constant by spectrophotometry, enzyme kinetics, use of immobilized enzyme electrode, adsorption isotherm
4	**Texts/References**	1. G. Svehla and B. Sivasankar, "Vogel's qualitative inorganic analysis, Pearson Education India, 7th Ed, 2023. 2. G. Mendham, R. C. Denney, J.D. Barnes, M. Thomas, B. Sivasankar, "Vogel's quantitative chemical analysis" Pearson education India, 6th Ed. 2009. 3. A. J. Elias, "A collection of interesting general chemistry experiments" Sangam Books Ltd. First Ed. 2002. 4. B. Viswanathan, and P. S. Raghavan, Practical Physical Chemistry, Viva Books, 2010 5. A. M. Halpern, and G. C. McBane, Experimental Physical Chemistry: A Laboratory TextBook, 3rd Edition, W. H. Freeman, 2006 6. B. S. Furniss, A. J. Hannaford, P.W.G. Smith, A.R. Tatchell, "Vogel's textbook of practical organic chemistry" Pearson education India, 5th Ed. 2003. 7. In-house laboratory manual with the experimental procedures and relevant literature.

1	**Title of the course** (L-T-P-C)	**Chemistry laboratory II (Old code: CH 312)** **0-0-3-3**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Inorganic chemistry: Complex material analyses: minerals/ alloys. Quantitative estimations using conductometry and spectrophotometry. Organic chemistry: Qualitative analysis of organic compounds. Chemical separation of binary mixtures and their qualitative analysis, Synthesis of organic compounds and chromatography Physical chemistry: Phase equilibria, viscosity and molecular weight of polymers, surface tension, reaction kinetics (rates, order of reaction, influence of ionic strength), use of thermocouples, transition temperature determinations.
4	**Texts/References**	• G. Svehla and B. Sivasankar, "Vogel's qualitative inorganic analysis", Pearson Education India, 7th Ed, 2023. • G. Mendham, R. C. Denney, J.D. Barnes, M. Thomas, B. Sivasankar, "Vogel's quantitative chemical analysis" Pearson education India, 6th Ed. 2009. • A. J. Elias, "A collection of interesting general chemistry experiments" Sangam Books Ltd. First Ed. 2002. • B. Viswanathan, and P. S. Raghavan, Practical Physical Chemistry, Viva Books, 1st Ed., 2010 • A. M. Halpern, and G. C. McBane, Experimental Physical Chemistry: A Laboratory TextBook, 3rd Edition, W. H. Freeman, 2006 • B. S. Furniss, A. J. Hannaford, P.W.G. Smith, A.R. Tatchell, "Vogel's textbook of practical organic chemistry" Pearson education India, 5th Ed. 2003. • In-house laboratory manual with the experimental procedures and relevant literature.

1	**Title of the course** (L-T-P-C)	**Chemistry laboratory III (CH 313)** **0-0-3-3**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• Inorganic chemistry: Determination of composition of complexes in solution. Synthesis and characterization of transition metal complexes (including organometallic compounds) and their study by various methods (spectral, thermal and magnetic etc). • Organic chemistry: Chemical separation of ternary mixtures and characterization of the components. Simple one or two step preparations involving different techniques, Isolation of naturalproducts, chromatographic analysis of complex mixtures, selectivity in synthesis, enzymatic and chemo-enzymatic synthesis, characterization, Analysis of biomolecules such as DNA and proteins and their spectrophotometric characterization • Physical chemistry: Determination of the following physical quantities: partial molal volumes, dipole moments, activities by freezing point, quantum yields, heats of vaporization and depressions of freezing points of solutions, velocity constant and activation energy. Electrodes with different substrates for H2 evolution, photoelectrochemical solar cells.Vacuum measurement. IR spectrum of HCl, Use of M.O. theory, solution of Schrodinger equation for polyatomics.
4	**Texts/References**	• G. Svehla and B. Sivasankar, "Vogel's qualitative inorganic analysis", Pearson Education India, 7th Ed, 2023. • G. Mendham, R. C. Denney, J.D. Barnes, M. Thomas, B. Sivasankar, "Vogel's quantitative chemical analysis" Pearson education India, 6th Ed. 2009. • A. J. Elias, "A collection of interesting general chemistry experiments"Sangam Books Ltd. First Ed. 2002. • B. Viswanathan, and P. S. Raghavan, Practical Physical Chemistry, Viva Books, 1st Ed., 2010 • A. M. Halpern, and G. C. McBane, Experimental Physical Chemistry: A Laboratory TextBook, 3rd Edition, W. H.Freeman, 2006. • B. S. Furniss, A. J. Hannaford, P.W.G. Smith, A.R.Tatchell, "Vogel's textbook of practical organic chemistry" Pearson education India, 5th Ed. 2003. • K. Wilson and J. Walker, "Principles and Techniques of Practical Biochemistry"Cambridge University Press 5th Ed., 2000 • In-house laboratory manual with the experimental ,procedures and relevant literature.

1	**Title of the course** (L-T-P-C)	**Chemistry laboratory IV** **0-0-3-3**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• Part A: Introduction to computational chemistry and the role of computers in chemistry, molecular simulations and programming, Introduction to applications of artificial intelligence/machine learning (AI/ML) in chemistry • Part B: Exposure and demonstration of sophisticated instruments such as UV-Vis-NIR spectrophotometer, Fluorimeter, Nuclear Magnetic resonance spectrometer, Infra-red spectrophotometer, mass spectrometer, and various chromatographic techniques (HPLC, GCMS, LCMS), Powder X-ray diffraction, BET etc.
4	**Texts/References**	• Donald A. McQuarrie, Quantum Chemistry, University Science Books, 2nd Edition 2008 • Andrew R. Leach, Molecular modelling principles and applications, Pearson Education Limited 2nd Edition, 2001 • Frank Jensen, Introduction to Computational Chemistry, John Wiley & Sons., 2017 • In-house laboratory manual with the experimental procedures and relevant literature.

1	**Title of the course** (L-T-P-C)	**Organometallic Chemistry and Catalysis** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• Organometallic Chemistry: 18-electron rule. Ligands: Carbo monoxide, phosphines, hydrides and dihydrogen complexes alkyl, -alkenyl, -alkynyl, and -aryl ligands, Alkene and -alkyn ligands, nonconjugated diene and polyene ligands, butadiene cyclobutadiene, and cyclooctatetraene, benzene and other arenes, the allyl ligand, cyclopentadiene and cycloheptatriene carbenes, alkanes, agostic hydrogens, dinitrogen and nitroge monoxide. • Compounds: d-Block carbonyls, metallocenes, metal–metal bonding and metal clusters. • Reactions: Ligand substitution, oxidative addition and reductive elimination, s-Bond metathesis, 1,1-migratory insertion reactions 1,2-insertions and b-hydride elimination, α, β, ✿-Hydride eliminations and cyclometallations. • Catalysis: Organometallic catalysts, Terminology in catalysis: Turnover, turnover number (TON), turnover frequency (TOF). Hydrogenation, Hydroformylation, Monsanto process, Wacker process, Ziegler-Natta polymerization, C-C coupling reactions Olefin Metathesis and metathesis polymerization, catalytic methods for the production of green hydrogen and ammonia • Organometallic Reagents: Organometallic compounds of s- block elements: Organo-lithium, beryllium and magnesium compounds.
4	**Texts/References**	• M. Weller, T. Overton, J. Rourke and F. Armstrong, Inorganic Chemistry, 6th edition, Oxford University Press, 2014. (South asia edition 2015) • E. Huheey, E. A. Keiter, R.L. Keiter and O. K. Mehdi, Inorganic Chemistry, Principles of Structure and Reactivity, 4th edition, Pearson, 2006. • D. Gupta and A. J. Elias; Basic Organometallic Chemistry: Concepts, Synthesis, and Applications, 2nd edition, Universities Press (India), 2013. • Organometallics by Christoph Elschenbroich, 3rd edition, 2006. • Atkins, P., et al., Shriver and Atkins Inorganic Chemistry, 5th edition, Oxford University Press, 2010. • The Organometallic Chemistry of the Transition Metals by Robert H Crabtree, 2014. • Inorganic Chemistry by Gary L. Miessler, Paul J. Fischer, and Donald A. Tarr, 5th edition, 2014.

1	**Title of the course** (L-T-P-C)	**Quantum Chemistry** **3-0-06**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Introduction: Importance; Historic background; Classical vs Quantum mechanics; Wave particle duality; Uncertainty principle. Postulates of quantum mechanics; Operator algebra; Properties of hermitian operators; Commutators. Schrodinger Equation: Wave function and interpretation; Time dependent and time independent Schrodinger equation; Eigenvalue problem. Quantum mechanics applicationsto model systems: Free particle; Particle-in-a-box (1D & 3D); harmonic oscillator; Tunneling; Rigid rotor. Hydrogen and hydrogen like atoms. Methods to obtain the approximatesolution of time independent Schrödinger equation: Perturbation theory; variational method; Applications. Many electron atoms: Spin and Pauli exclusion principle; Hund's rule; Slater determinants; Electronic term symbols.
4	**Texts/References**	• D. A. McQuarrie, Quantum Chemistry, Viva Student Edition, 2016 • I. R. Levine, Quantum Chemistry, Pearson publication, 7th Edition 2013 • A. Szabo and N. S. Ostlund, Modern Quantum Chemistry, Dover Publications, New Edition, 1996 • K L Kapoor, Physical Chemistry-Volume 4, McGraw Hill Education Pvt. Ltd, 6th Edition 2020.

1	**Title of the course** (L-T-P-C)	**Bioinorganic and Bioorganic chemistry** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Oxygen-activating proteins (cytochrome P450 and cytochrome c oxidase), electron transport proteins (blue copper proteins, Fe–S clusters, and cytochromes), photosystems, and hydrolase enzymes (carbonic anhydrase and peptidase). Metal transport and storage – Ferritin, Haemoglobin and myoglobin, Metals in medicine. Structure, function, properties and chemistry of the biological macromolecules (amino acids, proteins, carbohydrates, nucleic acids, and lipids). Enzymes and cofactors. Introduction to metabolism, Enzyme catalyzed reactions in biological pathways: group transfer, hydrolysis, amination, phosphorylation, reduction, oxidation, oxygenation, substitutions, carboxylation/decarboxylation, isomerization, eliminations, additions, Aldol and Claisen reactions, formylations/methylations, Rearrangements, and pericyclic reactions, Biorthogonal chemistry and chemical biology.
4	**Texts/References**	• W. Kaim and B. Schwederski, Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life, 2nd edition, Wiley, 2013. • R. R. Crichton, Biological Inorganic Chemistry – An Introduction, Elsevier, 2008. • Principles of Bioinorganic Chemistry, Stephen J. Lippard, Jeremy Mark Berg, 1994, University Science Publications. R. Silverman, "The organic chemistry of enzyme catalyzed reactions" Revised edition, Academic Press, 2002. • Inorganic Chemistry by Gary L. Miessler, Paul J. Fischer, and Donald A. Tarr, 5 th edition, 2014. • D. Vranken and G.A. Weiss "Introduction to Bioorganic Chemistry and Chemical Biology" 1st edition., Garland Science, 2012. • McMurry and Begley "The Organic Chemistry of Biological Pathways" 2nd edition., W H Freeman, 2015. • Nelson and Cox, "Lehninger Principles of Biochemistry", 7th edition., WH Freeman, 2017 • Hermann Dugas, "Bioorganic Chemistry: A ChemicalApproach to Enzyme Action, Springer; 3rd edition, 2012

1	**Title of the course** (L-T-P-C)	**Supramolecular chemistry and functional inorganic systems** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Basic concept and principles; Terminologies and nomenclature in supramolecular chemistry. Chemical interactions leading to supramolecular assemblies (Hydrogen Bonds, Non-covalent interactions), Molecular recognition and host-guest complementarity. Biological supramolecular systems: Ionophores, Porphyrin and other Tetrapyrrolic Macrocycles, Coenzymes, Neurotransmitters, DNA and Biochemical Self- assembly. Supramolecular reactivity Biomimetic systems and Artificial receptors (Cation Binding Hosts, Anion binding hosts, Ion Pair Receptors, Hosts for Neutral Receptors). Organic Crystal Structures, Polymorphism, Solvates, Co-Crystals.
4	**Texts/References**	• J. M. Lehn, Supramolecular Chemistry: Concepts and Perspectives, VCH, Weinheim, 1995. • V. Balzani (Editor), L. De Cola, SupramolecularChemistry, Wiley Kluwer, Dordrecht, 1992. • Supramolecular Chemistry by J. W. Steed & J. L. Atwood, 3rd edition John Wiley, 2022. • Crystal Engineering. The Design of Organic Solids by G.R. Desiraju, Elsevier, 1989. • Advances in Functional Inorganic Materials Prepared by Wet Chemical Methods, Aleksej Zarkov, Aivaras Kareiva, Loreta Tamasauskaite Tamasiunaite, Volume-II, MDPI, 2023.

1	**Title of the course** (L-T-P-C)	**Colloids and Surface Chemistry** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Colloid systems and their properties: Origin of the charges, electro-kinetic phenomena, electrophoresis, electroosmosis, sedimentation and streaming potential. The concept of electrical double layer and various models to explain its structure and properties, DLVO theory and stability of colloids. Smoluchowski theory of kinetics of coagulation and distribution of colloids aggregates. Organic and inorganic gels and clay colloids. Macromolecules: Concepts of mass and number average molecular weights, methods of determining molecular weights (osmometry, viscometry, diffusion and light scattering method), sedimentation, fractional properties of macromolecules, statistical distribution of end to end dimension, calculation of average dimension of various chain structures. Surfactants and Interfacial Phenomena: Classification, micellization, c.m.c. and its determination. Shape and structure of micelles, effect of additives on micellization, thermodynamics of micellization, solubilization and applications, effect of electrolytes on solubilization. Macro and micro emulsions, dispersion and aggregation of solids by surfactants Adsorption on solids and porous materials: Model for multilayer adsorption, BET isotherm and application to different types of adsorbents, adsorption by porous, non-porous and microporous solids. Estimation of specific surface area and pore size distribution. Special problem encountered with very narrow pore size material and adsorption from liquid phase.
4	**Texts/References**	• Hunter, R. J., "Foundation of Colloid Science", 2nd Edition, Oxford Univ. Press. 2000 • Lyklema, J., "Fundamentals of Interface and Colloid ,Science", Academic Press San Diego. 2005 • Adamson, A.W.,"Physical Chemistry of Surfaces", 6th Ed., John Wiley and Sons, New York. 1997 • Greg, S.J. and Singh, K.S.W., "Adsorption, Surface Area and Porosity", 2nd Ed., Academic Press. U K. 1997 • Flory P. J., "Principles of Polymer Chemistry", Asian books. 2007 • Rubinstein M. and Colby R. C., "Polymer Physics", 1st Ed., Oxford University Press. 2003.

1	**Title of the course** (L-T-P-C)	**Fundamentals of biophysical chemistry** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Structure of water, hydrophilic and hydrophobic interactions, Structure and conformations of proteins and nucleic acids, physical techniques for biological structure elucidation, thermodynamics and kinetics of ligand interactions and protein folding, Conformational transitions, Equilibrium across membranes, biophysical techniques
4	**Texts/References**	• R. B. Gregory, ed., Protein-Solvent Interactions, Marcel Dekker,Inc., 1995. • B.T. Nall and K. A. Dill, ed., Conformations and Forces in Protein Folding, American Association for the Advancement of Science, 1991. • J. Wyman and S. J. Gill, Binding and Linkage: Functional Chemistry of Biological Macromolecules, University Sciences Books, 1990. • C. R. Cantor and P. R. Schimmel, Biophysical Chemistry, Part III, W.H.Freeman and Co., 1980.

1	**Title of the course** (L-T-P-C)	**Green and sustainable Chemistry** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Introduction and metrics of green chemistry, Principles of green chemistry, Designing a sustainable synthesis, Bioremediation, Use of benign solvents in synthesis, Applications of green chemistry in real world, Renewable feedstock, Recycling of materials and chemicals, Toxic chemicals in environment, Green materials synthesis, New Green and sustainable synthetic methods, Society reliant chemicals, Bio catalysis, Green analytical methods, Alternate energy sources, Challenges and Future trends in Green chemistry.
4	**Texts/References**	• Anne E. Marteel-Parrish and Martin A. Abraham, Gre Chemistry and Engineering: A pathway to sustainability Wiley, 2014. • Manahan, S. E. Environmental Chemistry, Eighth Editi CRC Press, 2005. • Sankar, D; Nayim, S. A textbook of Green Chemistr 2021. • Anastas, P.T. & Warner, J.K.: Green Chemistry – Theo and Practical, Oxford University Press, 1998. • Lancaster, M. Green Chemistry: An Introductory Tex Third Edition; RSC Publishing, 2016. • Matlack, A.S. Introduction to Green Chemistry, Mar Dekker, 2001. • Ryan, M.A. & Tinnesand, M. Introduction to Gree • Chemistry, American Chemical Society, Washington, 2002.

1	**Title of the course** (L-T-P-C)	**Analytical Chemistry** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Statistics for analytical experimentation: Probability, Regression analysis, Accuracy and propagation of errors, Data analysis and signal enhancement. Covariance and correlation coefficient. Advanced chromatographic techniques: Theory of separation methods: HPLC, GC, GC/MS, LC/MS, GPC, and applications Electroanalytical techniques: Applications to chemical & biological systems: Potentiometry, Electrogravimetry, Voltammetry, Chronoamperometry, ion selective electrodes. And Thermoanalytical methods. Quantitative applications of Potentiometry and Voltammetry: Electrochemical sensors Spectrometric and Spectroscopic methods: Acid-base equilibria, Methodology in spectrochemical analysis, Spectrophotometry and binding assays. Introduction to electromagnetic radiation, Optical components of a spectrometer, Atomic absorption and emission spectroscopy, Principles and applications of Fluorimetry, Luminescence, Raman Spectroscopy and Dynamic lightscattering. Introduction to spectroscopy in time domain, Time- correlated single photon counting. Physical methods of characterization: Surface Techniques: Principles of Electron spectroscopy for chemical analysis, Scanning Probe Microscopy
4	**Texts/References**	• D. A. Skoog, F. J. Holler and S. R. Crouch, Principles of Instrumental Analysis, 6th Edition, Brooks/Cole Cengage Learning, Belmont, CA, 2007 • H. H. Willard, L. L. Merrln, Jr., J. A. Dean, and F. A. Senle, Jr., Instrumental Methods of Analysis: Wadsworth, 7th Edition, Belmont., 1989 • F. Rousseac and A. Roessac, Chemical Analysis: Modern Instrumentation Methods and Analysis, 4th Edition, John Wiley & Sons, Ltd., 2000 • J. Wang, Analytical Electrochemistry, 3rd Edition, Wiley – VCH, 2006 P.T. Kissinger and W. R. Heineman, Laboratory Techniques I Electroanalytical Chemistry, 2nd Edition, Marcel Dekker Inc., 1996 • B. Voigtlaender, Scanning Probe Microscopy: Atomic Force Microscopy and Scanning Tunneling Microscopy:, Springer Verlag, Berlin 2015

1	**Title of the course** (L-T-P-C)	**Principles of Biological Chemistry** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Structure and function of biomolecules, Biological membranes. Membrane channels and pumps, Signal transduction, Enzymes: classification, kinetics, mechanisms, regulation, and applications, Central Dogma of life, DNA Replication and Repair, Transcription, Translation, Genetic code, Genome and proteome, RNA chemistry, Recombinant DNA Technology, Primary Metabolism: Glycolysis, Citric acid Cycle, Gluconeogenesis, Oxidative phosphorylation, Pentose phosphate pathway, ß-oxidation, Amino acid transamination and urea cycle, Biosynthesis and secondary metabolism, Bioinformatics
4	**Texts/References**	• Nelson DL and Cox MM; Lehninger principles of Biochemistry, 8th edition, WH Freeman and company, 2021 • Berg JM, Tymoczko JL and Stryer L; Biochemistry, 9th edition, WH Freeman and company, 2019 • Voet D and Voet JG; Biochemistry, Fourth edition, John Wiley and Sons, 2011

1	**Title of the course** (L-T-P-C)	**Computational Chemistry** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Potential energy surfaces, Molecular mechanics force- fields, Fitting of force-fields, Electronic structure theory, Hartree-Fock method, Density Functional Theory, Multiscale Methods, Geometry optimization techniques, Normal mode analysis, Locating transition states, Nudged elastic band method, Dimer method Molecular dynamics simulations (Classical and Ab-initio), Molecular dynamics simulations in various ensembles, Modeling chemical reactions, Methods for computing free energy, Umbrella sampling, Metadynamics, Parallel tempering methods
4	**Texts/References**	• Donald A. McQuarrie, Quantum Chemistry, University Science Books, 2nd Edition 2008 • Dominik Marx and Juerg Hutter, Ab-initio molecular dynamics: Basic theory and advanced methods, Cambridge University Press 2009 • Mark E. Tuckerman, Statistical Mechanics: Theory and Molecular Simulation, Oxford University Press 2010 • Andrew R. Leach, Molecular modelling principles and applications, Pearson Education Limited, 2nd Edition 2001 • Daan Frenkel and Berend Smit, Understanding molecular simulation From Algorithms to Applications, Academic Press, 2nd Edition 2002 • Frank Jensen, Introduction to Computational Chemistry, John Wiley & Sons., 2017

1	**Title of the course** (L-T-P-C)	**Asymmetric Synthesis and Catalysis: From Basics to Frontiers** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	● Basics of asymmetric catalysis including energetics of reactions. ● Lewis acid, Lewis base, Brønsted acid and base catalysis, Phase-transfer catalysis. ● Resolution: kinetic, dynamic kinetic and parallel kinetic resolution; dememorization reactions. ● Mechanistic studies of asymmetric reactions: nonlinear effects, autocatalysis and autoinduction etc. ● Bifunctional, dual and multifunctional catalyst systems. ● Modern aspects of asymmetric catalysis: counterion- directed catalysis, cooperative, dual and merged, relay catalysis, asymmetric photocatalysis etc. ● Application of asymmetric catalysis in the total synthesis of natural products in current literature.
4	**Texts/References**	• Walsh, P. J., Kozlowski, M. C., Fundamentals of Asymmetric Catalysis, 1st Edition, University Science Books, California, 2008. • Carreira, E. M., Kvaerno, L., Classics in Stereoselective Synthesis, 1st Edition, Wiley-VCH, Weinheim, 2009. • Corey, E. J., Kürti, L., Enantioselective Chemical Synthesis, 1st Edition, Direct Book Publishing, Dallas,2010.

1	**Title of the course** (L-T-P-C)	**Chemistry of carbohydrates** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Introduction; structure, configuration, and conformation; Stereochemistry, and reaction of monosaccharides, deoxy and amino sugars, hexonic acid and vitamin C, disaccharides, polysaccharides, inositol; gan- gliosides and other glycosides. Chemistry of vitamins A,B,C and E. Common protecting groups and protecting group strategies; glycosylation: general concepts, various methods of glycoside bond formation; strategies in oligosaccharide synthesis: carbohydrate-based drug discovery, Carbohydrate biosynthesis and degradation
4	**Texts/References**	• B. G. Davis & A.J. Farbanks, Carbohydrate Chemistry, 1st Edition, Oxford University Press, 2002 • R. V. Stick., Carbohydrates: The Essential Molecules of Life, 2nd Edition, Academic Press, 2009 • D. E. Levy and P. Fugedi, The Organic Chemistry of Sugars, CRC Press, 2nd ed., 2006

1	**Title of the course** (L-T-P-C)	**Mathematics for Chemists** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• Linear algebra: scalar and vector, linear equations, matrix and determinant, diagonalization of matrices, eigenvalue and eigenvectors. • Differential Equations: Ordinary differential equations, general solutions, 1st and 2nd order differential equations, Fourie Transforms, statistics, mean, standard deviation, error estimates, Taylor series. • Numerical methods: Numerical differentiation and integration, interpolation, matrix eigenvalues, Numerical solution of differential equations.
4	**Texts/References**	• George Arfken, Hans Weber and Harris, Mathematical Methods for Physicists, Elsevier, 7th Edition, 2012 • Donald A. McQuarrie, Mathematical Methods for Scientists and Engineers, University Science Books, 2003 • Erwin Kreyszig, Advanced Engineering Mathematics International Student Version, J. Wiley and Sons, 10^{th} Edition- 2023

1	**Title of the course** (L-T-P-C)	**Radioactivity and Nuclear chemistry** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Radioactivity, Radioactive decay, Nuclear structure and stability, Nuclear models, Nuclear decay, Interaction of radiations with matter, Radiation detectors, Nuclear reactions, Nuclear Fission and fission, Production of radioisotopes, Radiochemical methods,Nuclear analytical techniques, Nuclear probes, Applications of radioisotopes, Actinide concept, Chemistry of actinides, Spectroscopy of actinides, Solution chemistry of actinides, Complexation and separation chemistry of actinides, Trans actinides and Actinide environmental chemistry
4	**Texts/References**	• D.D. Sood, A.V.R. Reddy and N. Ramamoorthy; Fundamentals of Radiochemistry, IANCAS Publication, 2007 • J.J. Katz, L.R. Morss, J.Fuger, and N.M. Edelstein; Chemistry of Actinide and Transactinide Elements, 3rd edition, Springer, Berlin Volume 1-5, 2006. • J.V. Katz; Nuclear and Radiochemistry: Fundamentals and Applications, WILEY-VCH GmbH, 2021

1	**Title of the course** (L-T-P-C)	**Electrochemistry and its Applications** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Ionics: Electrochemistry ofsolutions, Ion-solvent interactions,ion-ion interactions, ionic migration and diffusion. Phenomenological description of transport processes. Thermodynamics of galvanic cells: Equilibrium electrode potentials, IUPAC convention for electrode potentials, Thermodynamics of electrochemical cells and applications. Electrical Double layer: Theories of Double-Layer structure, diffuse-double-layer theory of Gouy and Chapman, the Stern Model, Adsorption of ions and neutral compounds, Electrocaplillary and differential capacitance measurements; Influence of double layer on charge transfer processes. Reference electrodes: polarizable and non-polarizable systems. Types of reference and working electrodes Electrode kinetics: Current-potential relationship (derivation ofButler-Volmer and Tafel equations). Adsorption isotherms forintermediates formed by charge transfer (Langmuir adsorption and its limitations, relating bulk concentration to surface coverage), Types of overpotentials: origin and minimization; mechanism of electro-organic reactions; hydrogen evolution and oxygen reduction reactions. transition state theory and Gibbs free energy of activation, bulk electrolysis; Quadratic activation –driving force relation –Marcus theory ; outer and inner sphere reactions. Underpotential deposition of metals and applications in catalysis. Corrosion: Different types of corrosion; influence of environment; Evans diagram, Pourbaix diagram; corrosion rate measurements; Stern Geary equation; mixed potential theory and prevention of corrosion.
4	**Texts/References**	• Gileadi, Physical Electrochemistry, Fundamental, Techniques and Applications, Wiley-VCH, 2011 • J. Bard and L. R. Faulkner, Electrochemical Methods: Fundamentals and Applications, 2nd Edition, Wiley, 2001 • L. I. Antrapov, Theoretical Electrochemistry, Intl Law & Taxation Publications, 2001. • J. J. O'M. Bockris and A. K. N. Reddy, Modern Electrochemistry, Vol. 1, Springer, 2018. • P. Atkins and J. de Paula, Atkins' Physical Chemistry, 8th edition, Oxford University Press, 2022. • Fundamentals of Electrochemistry, 2nd ed, Bagotsky, V.S., Hoboken: Wiley-Interscience 2006.