Curriculum for CST (2025 batch onward)

Total Credit: 282
BSE: 72
Core: 156
HSS: 24
Open Elective: 12
Departmental Elective: 18

Semester 1

Course Number	Course Type	Course Name	Credit Structure	Credit
CL1103	BSE	Fundamentals of Process Calculations	3006	06
MA1309 H	BSE	Single Variable Calculus	3104	04
MA1509 H	BSE	Multivariable Calculus	3104	04
PH1105 H	BSE	Introductory Classical Mechanics	2103	03
PH1111H	BSE	Modern Physics	2103	03
PH1115	BSE	Physics Lab	0033	03
ME1105	BSE	Engineering Mechanics	2106	06
CH1113L	BSE	Chemical Technology Laboratory I	0033	03
CH1112	DC	Organic Chemistry	3006	06
			Total	**38**

Semester 2

Course Number	Course Type	Course Name	Credit Structure	Credit
EE1203H	BSE	Electric Circuits	3003	03
EE1208H	BSE	Digital and Analog Electronics	3003	03
EE1213	BSE	Basic Electronics Laboratory	0033	03
CS1212	BSE	Programming and Data Structures	3006	06
CS1209	BSE	Programming Laboratory	0033	03
MA1409H	BSE	Linear Algebra	3104	04
MA1609H	BSE	Complex Analysis	3104	04
PH1207H	BSE	Introductory Electromagnetics	2103	03
DS1202H	BSE	Fundamentals of Data Science	3003	03
CH1206	Core	Introduction to Chemistry of Biomolecules	3006	06
			Total	**38**

Semester 3

Course Number	Course Type	Course Name	Credit Structure	Credit
MA	BSE	Ordinary differential equations	3104	04
MA	BSE	Partial differential equations	3104	04
CL	Core	Fluid Mechanics	2106	06
CH2101	Core	Introduction to Quantum Chemistry	3006	06
CH2102	Core	Inorganic Chemistry	3006	06
CH2103H	Core	Electrochemistry	3003	03
CH2104L	Core	Chemical Technology Laboratory II	0066	06
	HSS	HSS-01	3006	06
			Total	**41**

Semester 4

Course Number	Course Type	Course Name	Credit Structure	Credit
CH2002	Core	Chemical Kinetics	3006	06
CH2003	Core	Group Theory	3006	06
CH2004	Core	Applied Organic Chemistry	3006	06
CH2005	Core	Computational Chemistry	2026	06
CH2006L	Core	Chemical Technology Laboratory III	0066	06
	HSS	HSS-02	3006	06
			Total	**36**

Syllabus of Chemistry Courses

Semester 1 (Jul-Nov)

CH1112 Organic Chemistry

L-T-P-C: 3-0-0-6

Course Content/ Syllabus*:*

Introduction to types of organic reactions; Structure and stability of reactive intermediates: carbocations, carbanions, free radicals, carbenes, arynes and nitrenes; Methods of determining organic reaction mechanism: thermodynamic and kinetic requirements, transition state theory, Hammond postulate, Curtin-Hammett principle, kinetic vs. thermodynamic control reaction, isotope effects, substituent effects, Hammett linear free energy relationship, Taft equation; Addition reaction to C=C and C=O; Preliminary idea of radical reactions; Application of Oxidation and Reduction reactions and reagents, Name reactions - Sharpless epoxidation, Suzuki coupling, Heck coupling. Mechanism of aromatic nucleophilic and electrophilic substitutions; Introduction to synthesis of nucleic acids and peptide chemistry.

Texts:

1. E. V. Anslyn and D. A. Dougherty, Modern Physical Organic Chemistry, 1st Ed., University Science Books, California, 2006.
2. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry: Structure and Mechanisms (Part A and B), Kluwer Academic/ Plenum Pub., 2000

References:

1. P. Sykes, A guide to mechanism in Organic Chemistry, 6th Ed., Pearson Education, 2004.
2. M. B. Smith and J. March, Advanced Organic Chemistry, 6th Ed., John Wiley and Sons, Inc,2007.
3. D. Nasipuri, Stereochemistry of Organic Compounds, Wiley, 1994.

CH1113 Chemical Technology Laboratory I
L-T-P-C: 0-0-3-3
Course Content/ Syllabus*:*   Familiarization with Chemistry laboratory practice, safety, health, and environmental issues. Standardization of KMnO4 by Oxalic acid. Reaction of 4-Aminotoluene and o-Vanillin - Preparation of Azomethine. Transesterification reaction - Synthesis of Biodiesel. Synthesis and characterization of tris(acetylacetonato)-manganese(III). Determination of the dissociation constant of a weak acid using pH meter. Conductometric titration of a strong acid with a strong base. Determination of the total hardness of water by complexometric titration. Preparation of a Detergent.
Texts:
1. V. K. Ahluwalia, S. Dhingra, A. Gulati, *College Practical Chemistry*. Universities Press (India) Pvt. Ltd. 2005.

Semester 2 (Jan-May)

CH1206 Introduction to Chemistry of Biomolecules
L-T-P-C: 3-0-0-6
Course Content/ Syllabus*:*   Evolution of life: Origin of Life, Darwin's concepts of evolution. Introduction to biomolecules. Weak interactions in biomolecules. Basics of protein structure and functioning: primary, secondary, tertiary, and quaternary structures of proteins, protein folding, protein denaturation. Protein functioning: enzyme kinetics, enzyme inhibition. Lipids and Membranes: Common classes of lipids, self-association of lipids, liposomes, biological membranes, and membrane transportation. Basics of nucleic acid structure and function: structures and functions of DNA and RNA. Structures and properties of biological small molecules: vitamins, coenzymes. Basics of carbohydrates: structure and function.
Texts:
1. J. L. Tymoczko, J. M. Berg and L. Stryer, Biochemistry, 8th Ed, W. H. Freeman & Co, 2015.
2. D. L. Nelson and M. M. Cox, Lehninger Principles of Biochemistry, 7th Ed, Macmillan Worth, 2017.
References:
1. N. Hopkins, J. W. Roberts, J. A. Steitz, J. Watson and A. M. Weiner, Molecular Biology of the Gene, 7th Ed, Benjamin Cummings, 1987.
2. C. R. Cantor and P. R. Schimmel, Biophysical Chemistry (Parts I, II and III), W.H. Freeman & Co., 1980.

Semester 3 (Jul-Nov)

CH2101 Introduction to Quantum Chemistry
L-T-P-C: 3-0-0-6
Course Content/ Syllabus*:*   The motivation for Quantum mechanics: Historical background, postulates and general principles of quantum mechanics; Operators and their properties; Schrodinger equation, its application on some model systems : free-particle and particle in a box (1D and 3D), tunneling, the harmonic oscillator, the rigid rotator, and the hydrogen atom; Approximate methods; The variation theorem; Linear variation principle; Perturbation theory; Applications of variationalmethods and perturbation theory to the helium atom; Angular momentum: Eigenfunctions and eigenvalues of angular momentum operator, Ladder operator, addition of angular momenta; Spin- Pauli Exclusion Principle; Slater determinants; Term symbol (RS and jj coupling) and spectroscopic states, spin-orbit coupling and Zeeman splitting; Virial theorem; Born-Oppenheimer approximation; VB and MO theory, Application to H_2^+, H_2 molecule; Huckel molecular orbital theory and its application to ethylene, butadiene and benzene; Hybridization and valence MOs of some simple molecules.

Texts:
1. P. W. Atkins and R. S. Friedman, *Molecular Quantum Mechanics*, 3rd Ed., Oxford University Press,1997.
2. D. A. McQuarrie, *Quantum Chemistry*, Viva Books, 2003.
References:
1. I. N. Levine, *Quantum Chemistry*, Prentice Hall, 2003
2. F. L. Pilar, *Elementary Quantum Chemistry*, 2nd Ed., Dover Publications, Inc. NY, 1990.

CH2102 Inorganic Chemistry
L-T-P-C: 3-0-0-6
Course Content/ Syllabus*:* Acids and bases: classification, Lewis acid and base concept, hard acid, hard base classification, Pearson's HSAB concept and application; Oxidation and reduction: redox reactions, redox potential, electrochemical series, use of electrochemical series; Metallic chains, sheets and clusters; Metal silicates, zeolites and polyoxo-metallates; Metals and alloys, ceramic materials, intermetallic compounds and zintl phases; Chemistry of phosphorus, phosphorus oxides and phosphorus hydrides; Chemistry of oxyacids and oxyanion of nitrogen and phosphorus; Differences between the chemistry of nitrogen and phosphorus; Chemistry of the halogens: pseudo-halogen, inter-halogen; Oxides and oxyacids; Polyhalides; Chemistry of the rare gases: Chemistry of xenon, structure and bonding of xenon compounds; Non-aqueous solvents: types of solvents, general characteristics, reactions in non-aqueous solvents with reference to liquid NH_3 and liquid SO_2.Sulphur Chemistry: sulfides, suphur oxides, oxoacids.
Texts:
N. N. Greenwood and A. Earnshaw, Chemistry of the Elements, 2nd Ed., London: Butterworth Heinmann ,1997.
D. J. Shriver, P. W. Atkins and C. H. Langford, Inorganic Chemistry, 2nd Ed., Oxford ,1994.
References:
F. A. Cotton and G. W. Wilkinson, Advanced Inorganic Chemistry, 5th Ed., John-Wiley & Sons, 1988.
J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, Dorling Kindersley, 2006.
P. K. Dutt, Concepts of Chemistry, Levant Book, 2004.

CH2103H Electrochemistry
L-T-P-C: 3-0-0-3
Course Content/ Syllabus*:* Equilibrium Electrochemistry: Electrochemical cells, cell representation, types of electrodes, half reactions, standard potentials, types of electrochemical cells, cell reactions, cell EMF; Ionic activity and activity coefficients; Nernst equation and applications. Determining free energy and enthalpy from electrochemical measurements. Applications of standard potentials: electrochemical series, determination of activity coefficient; pH, pKa, solubility product; thermodynamic functions; Lithium ion battery and Fuel cells.Mechanism of electrode reactions: Overpotential; basics of dynamic Electrochemistry, Electrochemical corrosion and prevention.
Texts:
C. M. A. Brett and A. M. O. Brett, *Electrochemistry: Principles, Methods, and Applications*, Oxford University Press, 1994.
P. Atkins and J. de Paula, *Atkin's Physical Chemistry*, 7th Ed., Oxford University Press, 2002.
References:
T. Engel and P. Reid, *Physical Chemistry*, 1st Ed., Pearson Education, 2006.
G. W. Castellan, *Physical Chemistry*, 3rd Ed., Narosa Publishing House, 1985.

CH2104L Chemical Technology Laboratory II
L-T-P-C: 0-0-6-6

Course Content/ Syllabus*:*
Modern synthetic and analytical techniques to synthesize and characterize industrially important inorganic compounds; Use of electro-inorganic synthesis, photosynthesis and nano-material synthesis for the preparation of inorganic materials; Synthesis and characterization of alum, phosphate fertilizers, soaps and detergents, superconductors and nano-matertials; Environmental inorganic chemistry: preparation of clathrate compounds and applications in catalysis.
Texts:
G. Svehla, *Vogel's qualitative inorganic analysis*, 7th Edition, Pearson Education, New Delhi, 2006
J. Mendham, R. C. Denney, J. D. Barnes and M. J. K. Thomas, *Vogel's textbook of quantitative chemical analysis,* 6th Ed., Pearson Education, New Delhi, 2005.
A. J. Elias, *A Collection of Interesting General Chemistry Experiments*, Revised Ed., Universities Press (India) Pvt. Ltd, 2007.
K. Hutchings, *Classic Chemistry Experiments*, The Royal Society of Chemistry, London, 2000

Semester 4 (Jan-May)

CH2001 Technical report and presentation
L-T-P-C: 0-0-3-3
Course Content/ Syllabus*:*
Techniques to write scientific reports, journal articles; developing presentation skills, basic communication skills, power-point presentation and group discussions; practicing and presenting an article or a research topic; team presentation; selected technological topic related to the course / subject under the supervision of a faculty member.
Texts:
W. S. Pfeiffer, *Technical writing: A practical approach*, 2nd Edition., Prentice Hall, 1994.

CH2002 Chemical Kinetics
L-T-P-C: 3-0-0-6
Course Content/ Syllabus*:*
Rates of chemical reactions: rate laws and rate constants, reaction order, simple order reactions, composite reaction: consecutive reactions, parallel reactions; reversible reactions; relaxation method, Reaction mechanism, unimolecular reactions. Approximations in chemical kinetics: rate-determining step, steady-state and pre-equilibrium approximations, temperature dependence of rate, and Arrhenius parameters. Complex reactions: chain reactions, branched chain reactions, polymerization reactions, catalysis, autocatalysis, enzyme kinetics and inhibition, Autocatalysis and oscillatory reactions. Theories of chemical kinetics: Collision theory, activated complex theory. Solution and solid phase reactions: Ionic reactions, kinetic salt effect; Adsorption and surface catalysis. Unimolecular and bimolecular surface reactions.
Texts:
K. Laidler, Chemical Kinetics, 3rd Ed., Pearson Education, 2004.
G. M. Barrow, Physical Chemistry, 5th Ed., Tata Mcgraw-Hill, 1992.
References:
P. Atkins and J. de Paula, Atkin's Physical Chemistry, 7th Ed., Oxford University Press, 2002.
R. J. Silbey and R. A. Alberty, Physical Chemistry, 3rd Ed., John Wiley & Sons,2002.

CH2003 Group Theory
L-T-P-C: 3-0-0-6
Course Content/ Syllabus*:*
Definitions and Theorems of Group Theory: Properties of Group and examples, Subgroups, Classes. Molecular Symmetry and the Symmetry Groups: Symmetry elements and Operations: symmetry planes and reflections, the inversion Center, Proper Axes and proper rotation, and Improper axes and improper rotations. Products of symmetry Operations. Equivalent symmetry

elements and equivalent Atoms. General relations among symmetry elements and Operations. Symmetry Elements and Optical Isomerism. The symmetry point groups. Symmetries with multiple High- Order Axes. Classes of symmetry Operations. A systematic Procedure for symmetry Classification of molecules. Representations of Groups: Comments on Matrices and Vectors. Representation of groups. The "Great Orthogonality Theorem" and its consequences. Character Tables. Representation for Cyclic Groups. Group Theory and Quantum Mechanics: Wave function as bases for irreducible representations. The Direct Product. Detection of non-zero integrals. Symmetry Adapted Linear Combinations: Derivation of Projection Operators. Use of Projection Operators to construct SALCs. Molecular Orbital Theory and its Application in Organic Chemistry: General Remarks. Symmetry factoring of secular equations. Carbocyclic system. More general cases of LCAO-MO bonding. Naphthalene. Electronic excitations of Naphthalene:selection rules and configuration interaction. Three center Bonding. Symmetry based selection rules for cyclization reactions. Molecular Orbital Theory for Inorganic and Organometallic Compounds: Transformation Properties of Atomic Orbitals. Molecular orbitals for bonding in ABn molecules: The Tetrahedral AB4 cases. Molecular orbitals for bonding in ABn molecules.

Texts:

F. A. Cotton, Chemical Applications of Group Theory, 3rd Ed, John Wiley & Sons, 1990.

References:

Molecular Symmetry and Group Theory: "A Programmed Introduction to Chemical Applications" by Alan Vincent; 2nd Edition, Wiley.

CH2004 Applied Organic Chemistry

L-T-P-C: 3-0-0-6

Course Content/ Syllabus*:*

Fats, Oils and detergents: Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, hydrogenation of unsaturated oils, soaps, synthetic detergents, alkyl and aryl sulphonates; Synthetic polymers: polymerization, methods of polymerization, step growth polymerization, structure and physical properties, natural and synthetic rubbers; Synthetic dyes: Color and constitution (electronic concept), classification of dyes, synthesis of methyl orange, congo red, malachite green, crystal violet, phenolphthalein, fluorecein, alizarin and Indigo; Fuels and sources of Energy: Chemical fuels, classification of fuels, characteristic of fuel, calorific value and its determination, petroleum, cracking, reforming of petrol, knocking, antiknocking agent, diesel engine fuel, octane number, synthetic petrol, biodiesel; Liquid Crystals: Liquid crystal phase, classification of liquid crystals, chemical constitution and liquid crystalline behavior, molecular structure and liquid crystals, application of liquid crystal.

Texts:

R. T. Morrison and R. N. Boyd, *Organic Chemistry,* 6th Ed., Prentice-Hall, 2004.

B. Billmeyer, *Text book of Polymer Science,* 3rd Ed., John Wiley & Sons, 1984.

References:

I. L. Finar, *Organic Chemistry*, *Vols. 1 and 2*, 5th Ed., Pearson education, 2005.

D. Singh, B. Deshwal and S. K. Vats, *Comprehensive Engineering Chemistry,* I. K. International, Mumbai, 2007.

R. V. Gadag and A. N. Shetty, *Engineering Chemistry*, I. K. International, 2006.

M. P. Stevens, *Polymer Chemistry,* 3rd Ed., Oxford University Press Inc., 1998.

CH2005 Computational Chemistry

L-T-P-C: 3-0-0-6

Course Content/ Syllabus*:*

Computer programming in FORTRAN; Locating roots of equations; Numerical differentiation and integration; Systems of linear equations; Eigen value and eigenvector problems; Ordinary and partial differential equations: Euler, Runge-Kutta and finite difference methods; Solution to initial and boundary value problems; Problems on chemical kinetics; Solution of Newton's equation of motion; Solution of time-dependent Schrodinger equation for simple potentials. Approaches to

solve the time-independent Schrodinger's equation, Use of standard available softwares to perform simple quantum chemical calculations.
Texts:
S. J. Chapman, Fortran 90/95 for Scientists and Engineers, 2nd Ed., McGraw-Hill, 2003.
S. C. Chapra and P. Canale, Numerical Methods for Engineers 4th Ed., Tata McGraw -Hill, 2002.
P. W. Atkins and R. S. Friedman, Molecular Quantum Mechanics, 5th Ed., Oxford University Press, 2010.
References:
Numerical Recipes in FORTRAN/C by W. H. Press , S. A. Teukolsky, W. T. Vetterling and B. P. Flannery, Cambridge University Press, 2nd edition, 1996.
J. M. Thijssen, Computational Physics, 2nd Ed. Cambridge Uni. , 2007.
F. Jensen, Introduction to Computational Chemistry, 3rd edition, Wiley, 2017

CH2006L Chemical Technology Laboratory III
L-T-P-C: 0-0-6-6
Course Content/ Syllabus*:* Identification of unknown organic compounds: element detection, confirmation of the functional groups, derivatization; Separation technique: normal and reduced pressure distillation, solubility method, column chromatography method, sublimation; Isolation of medicinal compounds from plants/other sources: Soxhlet extraction; Preparation: aspirin, paracetamol, imidazole, dye preparation; multistep synthesis; Estimation of organic compounds: paracetamol, glucose; Characterization of unknown organic compounds by UV-Vis, IR and ^{1}H-NMR techniques; Experiment based on polymer science, electrophoresis, protein estimation, catalytic hydrogenation.
Texts:
J. R. Mohrig, T. C. Morrill, C. N. Hammond and D.C. Neckers, Experimental organic chemistry, W.H. Freeman and Co. ,1998.
N. K. Vishnoi, Advanced practical organic chemistry, Vikash publishing house Pvt. Ltd. ,1996.
B. S. Furniss, A.J. Hannaford, P.W.G. Smith, and A.R. Tatchell, Vogel's textbooks of practical organic chemistry, 5th Ed., ELBS Longman ,1994.
