DAV UNIVERSITY JALANDHAR

Course Scheme & Syllabus

For

M.Sc (Hons.)-CHEMISTRY

(Program ID-39)

1st to 4th SEMESTER

2023-2025

Scheme of Courses

M.Sc. (Hons.) Chemistry

Semester 1

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE501B	Core	Organic Chemistry-I	4	0	0	4
2	CHE502B	Core	Inorganic Chemistry-I	4	0	0	4
3	CHE503B	Core	Physical Chemistry	4	0	0	4
4	CHE504C	Core	Analytical Chemistry	4	0	0	4
5	CHE513	Core	Spectroscopy	4	0	0	4
6	CHE505B	Core	Organic Chemistry Lab-I	0	0	4	2
7	CHE506B	Core	Inorganic Chemistry Lab-I	0	0	4	2
8	Interdisciplinary Course-I						4
Total							28

Semester 2

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE507B	Core	Organic Chemistry-II	4	0	0	4
2	CHE508B	Core	Inorganic Chemistry-II	4	0	0	4
3	CHE509B	Core	Physical Chemistry-II	4	0	0	4
4	CHE510C	Core	Spectroscopy-I	4	0	0	4
5	CHE511B	Core	Organic Chemistry Lab-II	0	0	4	2
6	CHE512B	Core	Physical Chemistry Lab-I	0	0	4	2
7	Interdisciplinary Course-II						4
Total							24

Semester 3

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE601B	Core	Organic Chemistry-III	4	0	0	4
2	CHE602B	Core	Inorganic Chemistry-III	4	0	0	4
3	CHE603B	Core	Physical Chemistry-III	4	0	0	4
4	CHE604C	Core	Spectroscopy-II	4	0	0	4
5	CHE606B	Core	Inorganic Chemistry Lab-II	0	0	4	2
6	CHE607B	Core	Physical Chemistry Lab-II	0	0	4	2
7	CHE608B*	Elective	Seminar and Literature Survey	0	0	0	2*
8	CHE620B*	Elective	Advance Chemistry Lab-I	0	0	8	4*
9	Department Elective-I						4
	Total						26/28*
Department Elective-I							
1	CHE605B	Elective	Advanced Electrochemistry	4	0	0	4
2	CHE617B	Elective	Synthetic Organic Chemistry	4	0	0	4
3	CHE614B	Elective	Molecules of Life	4	0	0	4
4	PHY670	Elective	Nanoscience and Nanotechnology	4	0	0	4

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Only 20 students in the class will be enrolled for research projects based upon their merit/performance in MSc first year. The students with research projects will study CHE608B of 2 credits and the others will study CHE620B of 4 credits in the third semester.

Semester 4

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE609B	Core	Organic Chemistry-IV	4	0	0	4
2	CHE610B	Core	Bio-Inorganic Chemistry	4	0	0	4
3	CHE612B*	Elective	Project	0	0	0	6*
4	CHE621B*	Elective	Advance Chemistry Lab-II	0	0	8	4*
5	CEC101	Core	Community Engagement Course	1	0	0	1
6	CEC102	Core	Community Engagement Field Activities	1	0	0	1
7	Departmental Elective			4	0	0	4
8	Departmental Elective			4	0	0	4
	Total						22*/24*
Departmental Elective (Choose any Two courses)							
1	CHE611B	Elective	Bio-Physical Chemistry	4	0	0	4
2	CHE613B	Elective	Supramolecular Chemistry	4	0	0	4
3	CHE615B	Elective	Chemistry of Materials	4	0	0	4
4	CHE616B	Elective	Medicinal Chemistry	4	0	0	4
5	CHE618B	Elective	Advance Physical Chemistry	4	0	0	4
6	CHE619B	Elective	Analytical Techniques	4	0	0	4

***The students with research projects will do Project work (CHE612B) of 6 credits and the others will study Advance chemistry Lab-II (CHE621B) of 4 credits in the fourth semester.**

M.Sc. (Hons.) Chemistry

Semester 1

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE501B	Core	Organic Chemistry-I	4	0	0	4
2	CHE502B	Core	Inorganic Chemistry-I	4	0	0	4
3	CHE503B	Core	Physical Chemistry	4	0	0	4
4	CHE504C	Core	Analytical Chemistry	4	0	0	4
5	CHE513	Core	Spectroscopy	4	0	0	4
6	CHE505B	Core	Organic Chemistry Lab-I	0	0	4	2
7	CHE506B	Core	Inorganic Chemistry Lab-I	0	0	4	2
8	Interdisciplinary Course-I						4
Total							28

<table>
<tr><td>Course Code</td><td colspan="8">CHE501B</td></tr>
<tr><td>Course Title</td><td colspan="8">Organic Chemistry-I</td></tr>
<tr><td>Hours</td><td colspan="8">60 L:4, T:0, P:0</td></tr>
<tr><td>Credits</td><td colspan="8">4</td></tr>
<tr><td>Type</td><td colspan="8">Core</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:

CO1: Understanding of the structure, stability, and aromaticity of organic molecules
CO2: Understanding of various mechanisms and theories of reactivity based on structure and role of intermediates in common reactions
CO3: Understanding the mechanism and stereochemistry of nucleophilic and electrophilic substitution reaction at saturated carbon atom.
CO4: To understand the mechanism of aromatic electrophilic and nucleophilic substitution reactions.
CO5: To understand the basic concepts of stereochemistry and its application.
CO6: To understand the methods of conformational analysis.</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
</table>

Syllabus	**Unit 1: (15 hours)** • **Nature of Bonding in Organic molecules** Delocalized chemical bonding, conjugation, cross conjugation, resonance, hyperconjugation, tautomerism. Aromaticity: Concept of aromaticity, Huckel's rule, Polygon rule, Homo-aromatic, non-aromatic and anti-aromatic systems. Aromaticity in benzenoid and non-benzenoid molecules. alternant and non-alternant hydrocarbonsAnnulenes& hetero-annulenes. Physical methods to study aromaticity-UV, IR & 1H NMR. • **Reaction Mechanism: Structure and Reactivity** Type of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams. Methods of Determining Reaction Mechanism: Kinetic and non-kinetic methods, Identification of products, detection of intermediates, isotopic labeling, stereochemical evidences, cross-over experiments, Limitation of reactions, kinetic evidences and kinetic isotopic effects. Reaction Intermediates:Generation, structure, stability, reactivity, detection, trapping and reactions of classical and non-classical carbocations, carbanions, free radicals, carbenes, nitrenes and arynes.	CO1 CO2
	Unit 2: (15 hours) • **Aliphatic Nucleophilic Substitution** Aliphatic Nucleophilic Substitution Reactions: Mechanism and scope of aliphatic nucleophilic substitution reactions-SN1, SN2 and SNi. Stereochemistry of nucleophilic substitution reactions, allylic nucleophilic substitution reactions, Walden inversion, neighbouring group participation &anchimeric assistance, carbocation	

	rearrangements in neighboring group participation. Factors influencing the rates of nucleophilic substitution reactions. • **Aliphatic Electrophilic Substitution** Bio-molecular mechanisms-SE2 and SEi. The SE1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity. Elimination Reactions:Discussions of E1, E2 and E1cB mechanisms. Orientation during elimination reactions. Saytzeff and Hofmann rules. Reactivity-effects of substrate structures, attacking base, leaving group and solvent medium. Pyrolytic Eliminations: Mechanisms of pyrolysis of esters of carboxylic acids. Chugaev reactions, Hofmann degradation, Cope elimination and xanthate pyrolysis.	CO3
	Unit 3: (15 hours) • **Aromatic Electrophilic Substitution** Mechanism of aromatic electrophilic substitution reactions - nitration, halogenation, sulphonation, Friedel-Crafts alkylation and acylation, orientation and reactivity, energy profile diagram. The ortho/para ratio, ipso attack, orientation in other ring systems., Naphthalene, Anthracene, Six and five membered heterocycles, Diazonium coupling Mechanism of Vilsmeir-Haack reaction, Mannich reaction, Diazonium coupling, Pechmann reaction and Fries rearrangement, Gattermann – Koch reaction. • **Aromatic Nucleophilic Substitution** The SNAr, SN1 Benzyne and SNR1, Mechanisms, Reactivity effect of substrate structure, leaving group and attacking nucleophile.	CO4

	Unit 4: (15 hours) • **Stereochemistry** Optical Isomerism: Conformation and configuration of molecules, projection formulae, Fischer, Saw-horse, Newman and Flying wedge representations; Interconversion of these formulae. Absolute configuration (D, L) and (R, S) systems. Elements of symmetry, Pseudoassymmetric centres, chirality, molecules with more than one chiral centre, threo and erythro isomers, methods of resolution, stereospecific and stereoselective synthesis, asymmetric synthesis, Cram's and Prelog's rules. Geometrical Isomerism: Cis-trans isomerism resulting from double bonds, monocyclic compounds & fused ring systems. E, Z-notations, determination of configuration of geometrical isomers, syn & anti isomers. Optical activity in the absence of chiral carbon-biphenyls, allenes and spiranes. Conformational analysis of cycloalkanes and decalins. Effect of conformation on reactivity. Acyclic & cyclic systems-Substituted cyclohexanes, cyclohexanones, cyclohexanols, Stereochemistry of compounds containing nitrogen, sulphur and phosphorus.	CO5 CO6

Reference Books:

- **March, Jerry.** ***Advanced Organic Chemistry: Reactions, Mechanism and Structure***, John Wiley, 7th edition, 2013.
- **Carey, F. A. and Sundberg, R.J.** ***Advanced Organic Chemistry***, Plenum, 5th edition, 2008.
- **Sykes, Peter.** ***A Guide Book to mechanism in Organic Chemistry***, Longman, 6th edition, 2003.
- **Morrison, R. T. and Boyd, R. N.** ***Organic Chemistry***, Prentice Hall, 7th edition, 2010.

- **Kalsi, P. S.** ***Organic Reactions and their Mechanisms***, New Age International Publishers, 2nd edition, 2000.
- **Mukherji, S.M. and Singh, S.P.** ***Reactions Mechanism in Chemistry***, Vol. I, II, III, Macmillan, Revised edition, 2007.
- **Nasipuri, D.** ***Stereochemistry of Organic Compounds***, New Age International Publishers, 2nd edition, 1994.
- **Kalsi, P.S.** ***Stereochemistry of Organic Compounds***, New Age International, 2nd edition, 2008.
- **Kalsi, P.S.** ***Stereochemistry: Conformation and Mechanism***, Wiley Eastern Limited, 2nd edition, 2019.
- https://swayam.gov.in/explorer?category=Chemistry
- https://nptel.ac.in/course.html

<table>
<tr><td>Course Code</td><td colspan="8">CHE502B</td></tr>
<tr><td>Course Title</td><td colspan="8">Inorganic Chemistry –I (Transition Metal Chemistry)</td></tr>
<tr><td>Hours</td><td colspan="8">60 L:4, T:0, P:0</td></tr>
<tr><td>Credits</td><td colspan="8">4</td></tr>
<tr><td>Type</td><td colspan="8">Core</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:

CO1: The students will learn how this symmetry plays a major role in various characteristics/properties of molecules and metal complexes.
CO2: The students will have an idea of how symmetry subsequently leads to various spectroscopic states and how these spectroscopic states lead to a particular type of spectra in spectroscopy under study.
CO3: The students will learn to bridge the spectroscopic states formed from the splitting of terms (energy state) to the symmetry of the octahedral and tetrahedral metal complexes.
CO4: Will lead to a deep understanding of inorganic chemistry as this unit co-relates all the theories they study in their graduation classes with group theory and symmetry.</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Symmetry
Symmetry elements, symmetry operations and their matrix representation, group postulates and types,</td><td>CO1</td></tr>
</table>

	multiplication tables, point group determination, determination of reducible and irreducible representations, character tables, construction of character tables for C_{2v}, C_{3v}, use of symmetry in obtaining symmetry of orbitals in molecules, Determination of hybridization, vibrational modes and selection rules for electronic transitions in molecules using Character table • **Molecular Orbital Theory for Metal Complexes** Ligands symmetry orbitals and metal orbitals involved in molecular orbitals formation in octahedral complexes, MOEL diagrams for octahedral, tetrahedral and square planar complexes showing σ and π bonding in transition metal complexes.	
	Unit 2: (15 hours) • **Inter-electronic Repulsions** Spin-spin, orbital-orbital and spin orbital coupling, LS and jj coupling schemes, determination of all the spectroscopic terms of p^n, d^n ions, determination of the ground state terms for p^n, d^n, f^n ions using L.S. scheme, determination of total degeneracy of terms, order of interelectronic repulsions and crystal field strength in various fields, two type of electron repulsion parameters, spin orbit coupling parameters (λ) energy separation between different j states, The effect of octahedral and tetrahedral fields on S, P, D and F terms (with the help of character table). Splitting patterns of G, H and I terms	**CO2**
	Unit 3: (15 hours) • **Free Ions in Medium and Strong Crystal Fields** Strong field configurations, transition from weak to strong crystal fields, evaluation of strong crystal field terms of d^2 configuration in octahedral and tetrahedral	**CO3**

	crystal fields (using group theory), construction of the correlation energy level diagrams of d^2 configuration in octahedral field, study of energy level diagrams for higher configurations, Orgel diagrams, Tanabe Sugano diagrams, calculation of 10Dq and B with use of Orgel and Tanabe Sugano diagrams.	
	Unit 4: (15 hours) • **Electronic Spectra of Transition Metal Complexes** Variation of the Racah parameter, nephlauxetic effect-central field covalency, symmetry restricted covalency, differential radial expansion, spectrochemical series, band intensities, factors influencing band widths, Magnetic properties of transition metal ions and free ions presentive, Effects of L-S coupling on magnetic properties, Temperature independent paramagnetism (TIP) in terms of crystal field theory CFT and molecular orbital theory (MOT), Quenching of orbital angular momentum by crystal fields in complexes in terms of term-splitting. Effect of spin-orbit coupling and A, E & T states mixing, first order and second order Zeeman effects.	**CO4**

Reference Books:

- Cotton, F.A. Chemical Application of Group Theory, Wiley Eastern, 4th edition.
- Miessler, G.L. and Tarr, D.A. Inorganic Chemistry, Pearson Education, 5th edition.
- Figgis, B.N. Introduction to Ligand Field, WileyEastern.
- Lever, A.B.P. Inorganic Electronic Spectroscopy, Elsevier.
- Huheey, J.E.Inorganic Chemistry, Pearson, 5th Edition, 2009.
- Drago, R.S. Physical Method in Chemistry, W.B. Saunders Company.
- Cotton F.A. and Wilkinson, G. Advanced Inorganic Chemistry, Wiley Inter-science, 6th edition.
- Symmetry and Spectroscopy of Molecules by Kadaru Veera Reddy, Revised Second Edition.

- http://www.reciprocalnet.org/edumodules/symmetry/operations/index.html
- http://symmetry.otterbein.edu/tutorial/identity.html
- http://chemtube3d.com/solidstate/_table.htm

<table>
<tr><td>Course Code</td><td colspan="8">CHE503B</td></tr>
<tr><td>Course Title</td><td colspan="8">Physical Chemistry I</td></tr>
<tr><td>Hours</td><td colspan="8">60 L:4, T:0, P:0</td></tr>
<tr><td>Credits</td><td colspan="8">4</td></tr>
<tr><td>Type</td><td colspan="8">Core</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:

CO1: The students will be able to understand the concepts related to various partial molar properties.
CO2: The students will acquire knowledge of the concepts related to real gases and various methodologies for measurement
CO3:The student will get knowledge about various laws related to solutions and interpretation of phase diagrams
CO4:The students will be familiar with different types of statistical thermodynamics and partition functions
CO5:The students will gain knowledge about various laws, equations and phenomena, related to non-equilibrium thermodynamics</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
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<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
</table>

Syllabus	**Unit 1: (15 hours)** • **Partial Molar Properties** Recapitulation of thermodynamic laws, Partial molar quantities, chemical potential and Gibbs-Duhem equation, variation of chemical potential with temperature and pressure, chemical potential for an ideal gas, chemical potential of an ideal gas mixture (s), determination of partial molar volume, thermodynamic functions of mixing (free energy, entropy, volume and enthalpy), concept of escaping tendency and chemical potential. • **Real Gases: Concept of Fugacity and Activity** Concept of fugacity, methods for determining the fugacity of a real gas and its variation with temperature and pressure, activity, choice of standard states, dependence of activity on temperature and pressure.	CO1 CO2
	Unit 2: (15 hours) • **Solution & Phase Equilibrium** Solubility and factors affecting solubility, types of solutions, ideal solution, vapour pressure of ideal solutions, boiling point diagrams of binary miscible mixtures and their Distillation diagrams, azeotropes, critical solution temperatures, solubility of gases in liquids, Henry's law, Nernst distribution law, number of extractions, solutions of solids in liquids & chemical equilibrium. Derivation of Gibb's phase rule, phase equilibria of two component systems showing eutectic congruent and incongruent melting points.	**CO3**
	Unit 3: (15 hours) • **Statistical Thermodynamics** F.D. statistics, distribution law, Bose Einstein's statistics. (using Lagrange's method of undetermined multipliers).	**CO4**

	• **Partition functions:** Translational, Rotational, Vibrational, Electronic partitions functions. Calculation of Thermodynamic properties in terms of partition functions, Heat capacity, behavior of equilibrium constant in terms of partition function.	
	Unit 4: (15 hours) • **Non Equilibrium Thermodynamics** Meaning and scope of irreversible thermodynamics. Thermodynamic criteria for non-equilibrium states, Phenomenological laws-linear laws, Gibb's equation, Onsager's reciprocal relation, Entropy production-specific laws of entropy production, Non-equilibrium stationary states, Prigogine's principle of entropy production, Coupled phenomena, Some important applications.	**CO5**

Reference Books:

- An Introduction to Chemical Thermodynamics, R.P. Rastogi and R.R. Misra, Vikas Pub, 6th ed.2018.
- Physical Chemistry, P.W. Atkins, Oxford University Press, 9th ed.2010.
- Thermodynamics for Chemists, S. Glasstone, Affiliated East-West Press, 2008.
- Chemical Thermodynamics, I.M. Klotz and R.M. Rosenbers, Benzamin, Wiley, 1994.

<table>
<tr><td>Course Code</td><td colspan="8">CHE504C</td></tr>
<tr><td>Course Title</td><td colspan="8">Analytical Chemistry</td></tr>
<tr><td>Hours</td><td colspan="8">60 L:4, T:0, P:0</td></tr>
<tr><td>Credits</td><td colspan="8">4</td></tr>
<tr><td>Type</td><td colspan="8">Core</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:

CO1: Express knowledge related to quantitative and qualitative analysis and thermogravimetric analysis
CO2: Gain an understanding of X-Ray diffraction methods of analysis and their applications
CO3: Learn about basics and advanced Electroanalytical techniques
CO4: Get the comprehensive overview of the chromatography</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Elementary concepts
Qualitative and quantitative analysis, Preparation of samples for analysis, Solution concentration in terms of various conventions, Chemical stoichiometry, Random errors in chemical analysis, Gaussian and lorentzian distribution, Standard deviation and variance, Accuracy and precision, Standardization and calibration, Standard addition methods</td><td>CO1</td></tr>
</table>

	• **Thermo analytical or Thermometric Methods** Thermogravimetric analysis (TGA): Principle and method, automatic analysis, factors affecting results. Derivative Thermogravimetric analysis (DTG), applications. Differential thermal analysis (DTA): Principle and working, theory, simultaneous DTA-TGA curves, applications, Differential scanning calorimetry (DSC).	
	Unit 2: (15 hours) • **X-ray diffraction methods of analysis** Production of X-rays, solid state symmetry, reciprocal lattice, Bragg's law in reciprocal space, the powder method, interpretation of powder pattern of a cubic system, particle size determination by powder method, Qualitative and quantitative analysis using powder method. X-ray fluorescence spectroscopy, basics and its applications (qualitative and quantitative)	**CO2**
	Unit 3: (15 hours) • **Electroanalytical Techniques** Electrogravimetry: Without potential control and controlled potential, applications. Coulometric methods and applications. Voltammetry and polarography: linear sweep Voltammetry, voltammetric electrodes, voltammograms, voltammograms for mixtures. Polarography: currents, dropping mercury electrodes, pulse polarography, Cyclic Voltammetry, stripping methods, Amperometric titrations.	**CO3**
	Unit 4: (15 hours) • **Chromatography** Introduction, terminology, Band broadening and column efficiency, Variables that affect column efficiency, Gas chromatography (GC): Instrumentation for Gas-Liquid	**CO4**

	chromatography, columns, stationary phases, applications, Gas-Solid chromatography. High-Performance Liquid Chromatography (HPLC), instrumentation, partition chromatography, Ion-Exchange chromatography, Size-Exclusion chromatography, Comparison of HPLC and GC.	

Reference Books:

- **Christian G.D.** ***Analytical Chemistry***, John Wiley, 6th edition, 1994.
- **Skoog D.A., West, D.M., Holler, F.J. and Crouch, S.R.** ***Fundamentals of Analytical chemistry***, Brooks/Cole, 2004.
- **Skoog D.A.** ***Principles of Instrumental Analysis,*** Holt-Saunders International edition, 6rd edition, 2016.
- **Bassett, J., Denney, R.C., Jeffery, G.H. and Mendham, J.*Vogel's Textbook of Quantitative Inorganic Analysis (Revised),*** Orient Longman, 5th edition, 1989.
- **Willard H.H., Merritt L.L. Jr, Dean J.A. and Settle F.A. Jr.** ***Instrumental Methods of Analysis***, California: Wadsworth Publishing Company, 7th edition, 2004.

<table>
<tr><td>Course Code</td><td colspan="8">CHE513</td></tr>
<tr><td>Course Title</td><td colspan="8">Spectroscopy</td></tr>
<tr><td>Hours</td><td colspan="8">60 L:4, T:0, P:0</td></tr>
<tr><td>Credits</td><td colspan="8">4</td></tr>
<tr><td>Type</td><td colspan="8">Core</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:

CO1: Acquire the general features of spectroscopy and gain an understanding of pure rotational spectra
CO2: Learn about the basic and advanced concepts of UV-Visible spectroscopy
CO3: Learn about th basic knowledge of Vibrational and Raman spectroscopy
CO4: Understand the significance of nomenclature: used to describe various vibrations, use of symmetry considerations to determine the number of active infrared and Raman Lines (C2V molecules) and their applications</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
</table>

Syllabus	**Unit 1: (15 hours)** • **General Features of Spectroscopy** Units and conversion factors. Introduction to spectroscopy, Nature of radiation. Energies corresponding to various kinds of radiation, Experimental techniques, intensities of spectral lines, Selection rules and transition moments, Line widths, broadening. • **Pure Rotational Spectra** Classification of molecules according to their moment of inertia. Rotational spectra of diatomic molecules (rigid rotator), Intensities of spectral lines, isotopic substitution effects, non-rigid rotator, polyatomic linear and symmetric top molecules, Stark effect.	CO1
	Unit 2: (15 hours) • **UV and Visible Spectroscopy** Measurement techniques, Beer-Lambert's Law, molar extinction coefficient, oscillator strength and intensity of the electronic transition, Franck-Condon Principle, Ground and first excited electronic states of diatomic molecules, relationship of potential energy curves to electronic spectra, Chromophores, auxochromes, blue shift, red shift, hypo and hyperchromic effect, Solvent effects, transitions in organic molecules, Woodward rules for conjugated dienes, unsaturated carbonyl groups, extended conjugation and aromatic sterically hindered systems, Quantitative applications. Characterization of Inorganic compounds with UV-Visible spectroscopy.	**CO2**
	Unit 3: (15 hours) • **Vibrational Spectroscopy** **Theory of Infrared Absorption:** Harmonic and anharmonic oscillators, absorptions of radiation by molecular vibrations, selection rules, force constant,	**CO3**

	frequency of vibrational transitions of HCl, vibrations in a polyatomic molecule, 3N-6 and 3N-5 rules, types of vibrations, overtones, combination and difference bands, examples of CO_2, SO_2 and H_2O, Fermi resonance, group vibrations. **Raman Spectroscopy:** Introduction, selection rules, anisotropic polarizability, Stokes, anti-Stokes lines, vibrational Raman spectra of CO_2 and H_2O, polarized and depolarized Raman Lines, rule of mutual exclusion. Characterization of Inorganic compounds with Raman spectroscopy.	
	Unit 4: (15 hours) • **Determination of IR/Raman Active Modes:** Significance of nomenclature: used to describe various vibrations, use of symmetry considerations to determine the number of active infrared and Raman Lines (C_2V molecules). **Applications:** Physical state of a sample, cells used, Application of IR in structure elucidation of organic compounds-carbonyls and effect of substituents on it, CH, NH, OH vibrations and H-bonding, unsaturated, mono- and disubstituted aromatic compounds, metal-ligand vibrations, group frequencies of complex ligands-CN stretching and effect of coordination on it, nitro and nitrite and C=O ligands and effect of their coordination with metal ions.	**CO4**

Reference Books:

- **Drago, R.S.** ***Physical Methods for Chemists***, 2nd Edition, 2016.
- **Silverstein, R.M. Bassler, G.C. and Morrill, T.C.** ***Spectrometric Identification of Organic Compounds***, Wiley, 8th Edition.
- **Kemp, W.** ***Organic Spectroscopy***, Macmillan, 3rd Edition, 2019.
- **Dyer, J. R.** ***Application of Absorption Spectroscopy of Organic Compounds***, Prentice Hall, 1978.

- **Williams, D. H. and Fleming, I.** ***Spectroscopic Problems in Organic Chemistry,*** McGraw Hill, 6th Edition, 2007.
- **Barrow, G.M.** ***Introduction to Molecular Spectroscopy****,* McGraw Hill,1962.
- **Banwell, C.N.** ***Fundamentals of Molecular Spectroscopy,*** McGraw Hill, 2017, 4th Edition.
- **Pavia, D.L., Lampan, G.M. and Kriz, G. S.** ***Introduction to Spectroscopy****,* Hartcourt College Publishers, 5th Edition, 2013.
- **Parish, R.V.** ***Spectroscopy in Inorganic Chemistry***,Ellis Horwood Limited, 1990.

Course Code	**CHE505B**

<table>
<tr><td>Course Title</td><td colspan="8">ORGANIC CHEMISTRY LAB I</td></tr>
<tr><td>Hours</td><td colspan="8">04 L:0, T:0, P:4</td></tr>
<tr><td>Credits</td><td colspan="8">2</td></tr>
<tr><td>Type</td><td colspan="8">Core</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:

CO1: Understanding of various safety measures in Chemistry laboratories
CO2: To know the importance of calibration of instruments
CO3: To practice the synthesis of organic compounds</td></tr>
<tr><td>Examination Type</td><td colspan="8">Practical</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>20%</td><td>80%</td><td>0</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Practical</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">1. Organic Lab- (i) Safety: Eye, Fire and Chemicals (ii) Glassware (iii) Non-glass equipment (iv) Heating devices (v) Cleaning Glassware
2. To determine corrected melting points of an unknown organic compound (Calibration of thermometer).
3. Synthesis of Adipic acid from cyclohexanol (oxidation).
4. Synthesis of Aspirin from Salicylic acid.
5. Synthesis of benzyl alcohol and benzoic acid (Cannizzaro’s reaction).
6. Synthesis of Dibenzal acetone from benzaldehyde (Claisen-Schmidt reaction).</td><td></td></tr>
</table>

	7. Synthesis of Cinnamic acid from benzaldehyde (Knoevenaegal reaction). 8. Synthesis of Acetanilide and bromoacetanilide. 9. Synthesis of p-chlorotoluene from p-toludine 10. Synthesis of Benzanilide (Schotten-Baumann reaction). 11. Synthesis of o-Benzoylbenzoic acid (Friedel-Craft's reaction).	

Reference Books:

- **Harwood, L.M. and Moody, C.J.** ***Experimental Organic Chemistry***,Blackwell Scientific Publishers,1st edition, 1989.
- **Vogel, A.I.** ***Text Book of Practical Organic Chemistry***, ELBS,Longman Group Ltd.,5thedition,1978.
- **Mann, F.G. and Saunders, B.C.** ***Practical Organic Chemistry***,New Impression, Orient Longman Pvt. Ltd., 4th edition, 1975.
- **Leonard, J. and Lygo, B.** ***Advanced Practical Organic Chemistry***, Chapman and Hall, 1995.

Course Code	**CHE506B**							
Course Title	**INORGANIC CHEMISTRY LAB-I**							
Hours	04 L:0, T:0, P:4							
Credits	2							
Type	**Core**							
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills: **CO1: Perform and understand oxidation-reduction reactions** **CO2: Carry out and understand precipitation titrations** **CO3: Determine different ions using complexometric titrations** **CO4: Determine different cations using gravimetric analysis**							
Examination Type	Practical							
Assessment Tools	Written Quiz	Assignment/Project Work	MSE	MSP	ESE	LP	ESP	ABL/PBL
Weightage	**0**	**0**	**0**	**0**	**0**	**20%**	**80%**	**0**
Examination Mode	Practical							
Syllabus	**I. Oxidation-Reduction Titrations** 1. Standardization of $KMnO_4$with sodium oxalate and determination of Ca^{2+} ion. 2. Standardization of ceric sulphate with Mohr's salt and determination of Cu^{2+}, NO_2^- and $C_2O_4^{2-}$ ions. 3. Standardization of $K_2Cr_2O_7$ with Fe^{2+} and determination of Fe^{3+} (Ferric alum) 4. Standardization of hypo solution with potassium iodate / $K_2Cr_2O_7$ and determination of available Cl_2 in bleaching powder, Sb^{3+} and Cu^{2+}. 5. Determination of hydrazine with KIO_3 titration. **II. Precipitation Titrations** 1. $AgNO_3$ standardization by Mohr's method.								

	2. Volhard's method for Cl^- determination. 3. Determination of ammonium / potassium thiocyanate. **III. Complexometric Titrations** 1. Determination of Cu^{2+} and Ni^{2+} by using masking reagent by EDTA titration. 2. Determination of Ni^{2+} (back titration). 3. Determination of Ca^{2+} (by substitution method). **IV. Gravimetric Analysis** 1. Determination of Ba^{2+} as its chromate. 2. Estimation of lead as its lead sulfate. 3. Estimation of Nickel (II) as its nickel dimethyl glyoximate. 4. Estimation of Cu^{2+}as cuprous thiocyanate.	

Reference Books:

- Svehla,G. and Sivasankar,B.*Vogel's Qualitative Inorganic Analysis (revised),*Pearson, 7th edition, 1996.

Semester 2

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE507B	Core	Organic Chemistry-II	4	0	0	4
2	CHE508B	Core	Inorganic Chemistry-II	4	0	0	4
3	CHE509B	Core	Physical Chemistry-II	4	0	0	4
4	CHE510C	Core	Spectroscopy-I	4	0	0	4
5	CHE511B	Core	Organic Chemistry Lab-II	0	0	4	2
6	CHE512B	Core	Physical Chemistry Lab-I	0	0	4	2
7	Interdisciplinary Course-II						4
Total							24

L: Lectures T: Tutorial P: Practical Cr: Credits

<table>
<tr><td>Course Code</td><td colspan="8">CHE507B</td></tr>
<tr><td>Course Title</td><td colspan="8">Organic Chemistry -II</td></tr>
<tr><td>Hours</td><td colspan="8">60 L:4, T:0, P:0</td></tr>
<tr><td>Credits</td><td colspan="8">4</td></tr>
<tr><td>Type</td><td colspan="8">Core</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:

CO1: To understand the mechanistic and stereochemical aspects of addition reactions to Carbon-Carbon multiple bonds
CO2: To understand the pathways of addition reaction to carbon-heteroatom multiple bonds.
CO3: To understand the various oxidative process of hydrocarbons and alcohols
CO4: To study the several reducing agents for various reductive process of aliphatic, aromatic and carbonyl compounds.
CO5: To analyze the role of free radicals as an intermediate in common reactions.
CO6: To understand the various rearrangement reactions in organic chemistry.</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Addition to Carbon-Carbon Multiple Bonds</td><td></td></tr>
</table>

	Mechanistic and stereochemical aspects of addition reaction involving electrophiles, nucleophiles and free radicals, regio and chemo selectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic ring. Hydroboration. Michael reaction, Sharpless asymmetric epoxidation. • **Addition to Carbon-Heteroatom Multiple Bonds** Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds acids, esters and nitriles. Addition of Grignard reagents, organozinc, organolithium, organocuprate reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction, Horner-Wadsworth-Emmons (HWE) reaction. Mechanism of condensation reactions involving enolates-Aldol,	CO1 CO2
	Unit 2: (15 hours) • **Oxidation Reactions** Introduction. Different oxidative processes. Oxidation of Hydrocarbons- alkenes, aromatic rings, aryl methanes, allylic oxidation of olefins. Oxidation of alcohols: Swern Oxidation, PCC, PDC oxidation, Oxidations with ruthenium tetraoxide, iodobenzene diacetate and thallium (III) nitrate, DDQ, CAN, selenium dioxide, peroxyacids, DCC. Baeyer-Villeger reaction, Cannizarro oxidation-reduction reaction	CO3
	Unit 3: (15 hours) • **Reduction Reactions** Introduction. Different reductive processes, Hydrogenation of alkenes, alkynes and aromatic rings, Carbonyl compounds – aldehydes, ketones, acids, ester and nitriles. Epoxides, Nitro, nitroso, azo and oxime groups, Hydrogenolysis. Sodium borohydride, sodium cyano borohydride, LAH, disobutyl aluminium hydride, tin hydride, trialkyl tinhydride, trialkyl silanes, alkoxy substituted LAH, DIBAL, diborane, diisoamyl	CO4

	borane, hexyl borane, 9-BBN, isopinocamphenyl and disiopinocamphenyl borane. Wolf-Kishner reduction, Clemensen reduction. • **Free Radical Reactions** Types of free radical reactions, free radical substitution mechanism at an aromatic substrate, neighbouring group assistance, Reactivity for aliphatic and aromatic substrates at a bridgehead. Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation. Coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction, Free Radical Rearrangement, Hunsdiecker reaction.	CO5
	Unit 4: (15 hours) • **Rearrangements** General mechanistic considerations-nature of migration, migratory aptitude, memory effects A detailed Study of the following rearrangements Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil- Benzilic Acid, Favorskii, Arndt Eistert synthesis, Neber, Beckmann, Hoffman, Curtius, Schmidt, Baeyer- Villiger, Shapiro reaction, Cope rearrangement, Claisen rearrangement, dienone-phenol, Wolf, Stevens (in cyclic systems).	CO6

Reference Books:

- **Carruthers, W. and Coldham, I.** ***Some Modern Methods of Organic Synthesis***, IV edition, Cambridge University Press, 2004.
- **March, Jerry.** ***Advanced Organic Chemistry: Reactions, Mechanism and Structure***, John Wiley, 7th edition, 2013.
- **Carey, F. A. and Sundberg, R.J.** ***Advanced Organic Chemistry***, Plenum, 5th edition, 2008.
- **Sykes, Peter.** ***A Guide Book to mechanism in Organic Chemistry***, Longman, 6th edition, 2003.
- **Morrison, R. T. and Boyd, R. N.** ***Organic Chemistry***, Prentice Hall, 7th edition, 2010.

- **Kalsi, P. S.** ***Organic Reactions and their Mechanisms***, New Age International Publishers, 2nd edition, 2000.
- **Mukherji, S.M. and Singh, S.P.** ***Reactions Mechanism in Chemistry***, Vol. I, II, III, Macmillan, 2003.
- **Aggarwal, O.P.** ***Organic Chemistry Reactions and Reagents***, Krishna Prakashan Media, 47th edition, 2011.
- **Mundy, B. P.** ***Name Reactions and Reagents in Organic Synthesis***, 2nd edition, 2005
- https://nptel.ac.in/course.html

Course Code	**CHE508B**
Course Title	**Inorganic Chemistry -II**

<table>
<tr><td>Hours</td><td colspan="8">60 L:4, T:0, P:0</td></tr>
<tr><td>Credits</td><td colspan="8">4</td></tr>
<tr><td>Type</td><td colspan="8">Core</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:

CO1: The students will become aware of the various inorganic compounds categorized according to their shapes like chains, rings, or cages. Which are the elements which make such compounds and their physical and chemical nature?
CO2: The students will learn about cluster compounds that involve metal-metal interactions. It includes different structural types; bonds, the relation of clusters to multiple bonds and one-dimensional solids.
CO3: This course is also about the applications of transition metal complexes as catalysts. This includes their classification, mechanisms and various reactions involved and the stereochemistry of the products formed
CO4: This course introduces nuclear reactions: fusion and fission, radio-analytical techniques and activation analysis and radiation chemistry of Inorganic Solids.</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Inorganic chains, rings and cages
a) Chains: Catenation, heterocatenation (Silicate structures, silicate minerals, Zeolites), Intercalation Chemistry, One -</td><td>CO1</td></tr>
</table>

	dimensional semiconductors, isopolyanions and heteropolyanions. b) **Rings:** Borazines, phosphazenes, phosphazenes polymers, other heterocyclic inorganic ring systems, homocyclic inorganic systems. c) **Cages:** Cage compounds having phosphours, oxygen, nitrogen and sulphur: boron cage compounds, Boranes, Symmetric and asymmetric cleavage in diborane and tetraborane, STYX rule, carboranes and metallocene carboranes.	
	Unit 2: (15 hours) • **Transition metal cluster compounds** Introduction, metal carbonyl clusters; Low Nuclearity (M_3 and M_4) clusters: isoelectronic and isolobal relaltionships high nuclearity carbonyl clusters; hetero atoms in metal atom clusters, electron counting schemes for HNCC: HNCC of Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt. Hexanuclear clusters, Lower halide and chalcogenide clusters, octahedral metal halide, chalocogenide clusters, triangular clusters, and solid state extended arrays, Compounds with M-M multiple bonds; Major structural types; quadrupole bonds, other bond orders in the tetragonal context, relation of clusters to multiple bonds, one dimensional solids.	**CO2**
	Unit 3: (15 hours) • **Reaction Mechanisms of Transition Metal Complexes I** Introduction, Ligand substitution reactions: Rates of ligand substitution, The classification of mechanisms, Ligand substitution in square-planar complexes, The nucleophilicity of the entering group, The shape of the transition state, Ligand substitution in octahedral complexes, Rate laws and their interpretation, The activation of octahedral complexes, Base	**CO3**

	hydrolysis, Redox reactions: The classification of redox reactions, The inner-sphere mechanism, The outer-sphere mechanism, Metal carbonyl reactions, reactions of binuclear carbonyls, associative reactions, species with 17 electron,	
	Unit 4: (15 hours) • **Reaction Mechanisms of Transition Metal Complexes II** The Marcus theory, doubly bridged inner-sphere transfer, other electron transfer reactions; two electron transfers, Non-complementary reaction, Ligand exchange via electron exchange, reductions by hydrated electrons, stereochemically non-rigid coordination compounds, Trigonal bipyramidal molecules, systems with coordination number six or more, isomerization and recombination's, tris chelate complexes, metal carbonyl scrambling cluster, rotation within Coshells. • **Nuclear Chemistry** Introduction, Nuclear Reactions: fusion and fission, radio-analytical techniques and activation analysis, Radiation Chemistry of Inorganic Solids.	**CO4**

Reference Books:

- **Huheey, J.E.Inorganic Chemistry**, Pearson, 5th edition, 2009.
- **Cotton, F.A. and Wilkinson, G.** ***Advanced Inorganic Chemistry***, Wiley eastern, 6th edition.
- **Shriver,D.F.,Atkins,P.W. and Langford,C.H.** ***Inorganic Chemistry***, ELMS, Oxford, 6th edition.
- **William W. Porterfield, Inorganic Chemistry**, 1st edition.
- **K.F. Purcell and J.C. Kotz.An Introduction to Inorganic Chemistry**.
- **Handbook of Nuclear Chemistry: Chemical applications of nuclear reactions and radiations**, Volume 3, By Rezső G. Lovas, 2003
- https://www.adichemistry.com/inorganic/p-block/group-14/silicates/silicates-2.html

Course Code	**CHE509B**
Course Title	**Physical Chemistry -II**
Hours	60 L:4, T:0, P:0
Credits	4

<table>
<tr><td>Type</td><td colspan="8">Core</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:
CO1: The students will gain knowledge about the concepts related to various laws, theories, models, and methods of chemical kinetics.
CO2: The students will gain knowledge about various theories and concept related to electrochemistry of electrolytic solutions.
CO3: The students will gain knowledge of Surface Chemistry
CO4: The student will get knowledge of colloidal Chemistry
CO5: The student will get knowledge of macromolecules</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Chemical Kinetics
Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation, concept of energy of activation, potential energy surfaces, steady state kinetics, Lindemann-Christiansen hypothesis, Hinshelwood treatment and Rice Ramsperger-Kassel-Marcus (RRKM) theories of unimolecular reactions, General features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and nuclear magnetic resonance method, Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical (hydrogen bromine and hydrogen-chlorine reactions).</td><td>CO1</td></tr>
</table>

	Unit 2: (15 hours) • **Electrochemistry** Debye-Hückel theory of ion-ion interaction and activity coefficient, ionic strength, applicability and limitations of Debye-Hückel limiting law, its modification for finite-sized ions, effect of ion-solvent interaction on activity coefficient. Physical significance of activity coefficients, mean activity coefficient of an electrolyte. Debye-Huckel-Onsager (D-H-O) theory of electrolytic conductance, Debye-Falkenhagen effect, Wein effect, D-H-O equation - its applicability and limitations, Pair-wise association of ions (Bjerrum treatment), Modification of D-H-O theory to account for ion-pair formation.	**CO2**
	Unit 3: (15 hours) • **Surface Chemistry and Catalysis** Gibbs adsorption equation, Langmuir adsorption isotherm, BET adsorption isotherm, its derivation and applications. Study of surfaces by STM, SEM, Heterogeneous catalysis, surface heterogeneity, surface catalyzed unimolecular and bimolecular reactions, temporary and permanent catalytic poisons, activation energy for surface reactions. **Colloidal State** Classification of colloids, Hardy-Schulze Law, gold number, electrical properties of colloids, electrical double layer and its structure, Stern's theory of double layer, zeta-potential, electrophoresis and electro osmosis, emulsions and their classification, emulsifiers, gels and their classification, Thixotropy, Application of colloids. **Micelles:** Surface active agents, classification of surface active agents, micellisation, hydrophobic interactions, critical micellar concentration, thermodynamics of micellization-phase separation & mass action models, reverse micelles.	**CO3** **CO4**

	Unit 4: (15 hours) • **Macromolecules** Basic concepts, Kinetics of Polymerization, Mechanism and Kinetics of chain growth polymerization, free-radical, cationic, anionic and coordination polymerization, Mechanism and Kinetics of step-growth polymerization, Molecular mass of polymers, Significance of average molecular mass, Poly-dispersity, Determination of molecular mass by (osmometry, viscosity, diffusion, light scattering, and sedimentation methods.	**CO5**

Reference Books:

- **Chemical Kinetics, K.J. Laidler**, McGraw Hill.
- **Kinetics and Mechanism, A. A. Frost and R.G. Pearson**, John Wiley and Sons.
- **Electrochemistry, S. Glasstone,** Affiliated East-West Press, 2007.
- **Physical Chemistry**, G.W. Castellan, Narosa, 2004.
- **Heterogeneous Catalysis: Fundamentals and Applications**, Julian R.H. Ross, Wiley-Pub, 2016
- **Concepts of Modern Catalysis and Kinetics**, I. Chorkendorff and J. W. Niemantsverdriet, 2007.
- **Micelles: Theoretical and Applied Aspects**, Moroi, Y. Plenum Press.
- **Modern Electro-Chemistry**, Bockris, John O'M; Reddy, Amulya K.N. Plenum Press, New York, 2001.
- **Physical Chemistry of Surfaces,** Adamson, W.A. Arthur, Wiley-Interscience Publication, 6th ed.
- **Polymer Chemistry,** Billmayer, Wiley Interscience, 2007
- **Principles of Polymerization**, Geroge Odian, 2004

Course Code	**CHE510C**
Course Title	**Spectroscopy-I**
Hours	60 L:4, T:0, P:0
Credits	4

<table>
<tr><td>Type</td><td colspan="8">Core</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:

CO1: Become proficient in Nuclear Magnetic Resonance spectroscopy understanding the concepts of chemical shift, spin-spin coupling and applications to organic molecules in structure determination.
CO2: Understand the principle and applications of 13C NMR and 2D NMR
CO3: Learn about the principle of mass spectrometry and its applications
CO4: Become competent in understanding NMR of Inorganic compounds</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Nuclear Magnetic Resonance Spectroscopy
PMR: Natural abundance of ^{13}C, ^{19}F and ^{31}P nuclei; The spinning nucleus, effect of external magnetic field, processional motion and frequency, Energy transitions, Chemical shift and its measurements. Factors influencing chemical shift, anisotropic effect; Integrals of protons, proton exchange, spin-spin coupling-splitting theory, one, two and three bond coupling, virtual, long range and allylic coupling, magnitude of coupling constant; factors affecting the coupling constant, Chemical and magnetic equivalence, First and second order spectra, A_2, AB, AX, AB_2, AX_2, A_2B_2 and A_2X_2 spin systems, Simplification of complex spectra (solvent effect, field effect, double resonance and lanthanide shift</td><td>CO1</td></tr>
</table>

	reagents), CW and FT NMR, Relaxation processes,, Applications of PMR in structural elucidation of simple and complex compounds.	
	Unit 2: (15 hours) • **^{13}C-NMR Spectroscopy** Resolution and multiplicity of ^{13}C NMR, Factors affecting chemical shift values, ^{1}H-decoupling, noise decoupling, broadband decoupling; Deuterium, fluorine and phosphorus coupling; NOE and origin of nuclear overhauser effect, off-resonance, proton decoupling, Structural applications of 13C-NMR, Introduction to 2D-NMR, pulse sequences, pulse widths, spins and magnetization vectors, DEPT, INEPT, COSY, NOESY, HSQC spectra.	**CO2**
	Unit 3: (15 hours) • **Mass Spectrometry** Introduction, methods of ionization EI & CI, Brief description of LD, FAB, SIMS, FD etc., Ion analysis methods (in brief), isotope abundance, Metastable ions, general rules predicting the fragmentation patterns. Nitrogen rule, determination of molecular ion peak, index of H deficiency, fragmentation patterns for aliphatic compounds, amines, aldehydes, Ketones, esters, amides, nitriles, carboxylic acids ethers, aromatic compounds etc.	**CO3**
	Unit 4: (15 hours) • **NMR of Inorganic Compounds** Fundamentals, Complications, 1H spectra-organometallics, phosphine and arsine ligands, hydrides, Phosphorus-31, Carbon-13, Nitrogen-14 and Nitrogen-15, Fluorine-19, Aluminium-27, Silicon-29, Transition metals, 2D-NMR.	**CO4**

Reference Books:

- **Drago, R.S.** ***Physical Methods for Chemists***, 2nd Edition, 2016.

- **Silverstein, R.M. Bassler, G.C. and Morrill, T.C.** ***Spectrometric Identification of Organic Compounds***, Wiley, 8th Edition.
- **Kemp, W.** ***Organic Spectroscopy***, Macmillan, 3rd Edition, 2019.
- **Dyer, J. R.** ***Application of Absorption Spectroscopy of Organic Compounds***, Prentice Hall, 1978.
- **Williams, D. H. and Fleming, I.** ***Spectroscopic Problems in Organic Chemistry***, McGraw Hill, 6th Edition, 2007.
- **Barrow, G.M.** ***Introduction to Molecular Spectroscopy***, McGraw Hill,1962.
- **Banwell, C.N.** ***Fundamentals of Molecular Spectroscopy***, McGraw Hill, 2017, 4th Edition.
- **Pavia, D.L., Lampan, G.M. and Kriz, G. S.** ***Introduction to Spectroscopy***, Hartcourt College Publishers, 5th Edition, 2013.

Course Code	**CHE511B**
Course Title	**ORGANIC CHEMISTRY LAB-II**
Hours	04 L:0, T:0, P:4
Credits	2
Type	**Core**

<table>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:

CO1: To prepare the various organic compounds by multistage methods.
CO2: To know the separations of compounds and their identification.
CO3: To check the purity of compounds by melting point determination</td></tr>
<tr><td>Examination Type</td><td colspan="8">Practical</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>20%</td><td>80%</td><td>0</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Practical</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Preparation of the following organic compounds:
1. Hydroxynaphthaldehyde (Reimer Tiemann Reaction)
2. Benzoin, Benzil and Benzilic acid.
3. Benzophenone, Benzophenone oxime, Benzanilide (Beckmann Rearrangement).
4. Alkylation of diethyl malonate with benzyl chloride
Qualitative Analysis of mixtures of organic solids:
Separation of the compounds and their identification through various steps, derivative preparation, checking the purity of components by melting point.</td><td></td></tr>
</table>

Reference Books:

- **Harwood, L.M. and Moody, C.J.** ***Experimental Organic Chemistry***, BlackwellScientific Publishers, 1st edition, 1989.
- **Vogel, A.I.** ***Text Book of Practical Organic Chemistry***, ELBS, LongmanGroup Ltd.,4th edition,.
- **Mann, F.G. and Saunders, B.C.** ***Practical Organic Chemistry***, 4th edition, NewImpression, Orient Longman Pvt. Ltd., 1975.

- **Leonard, J. and Lygo, B.** ***Advanced Practical Organic Chemistry***, Chapman and Hall,1995.

Course Code	**CHE512B**
Course Title	**PHYSICAL CHEMISTRY LAB-I**
Hours	04 L:0, T:0, P:4
Credits	2
Type	**Core**

<table>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:

CO1: The students will gain an understanding of the preparation for each experiment by studying lab handouts and links therein
CO2: The students will understand about safety requirements and lab skills to perform physico-chemical experiments
CO3: The students will learn how to keep records of instruments, parameters, and experimental observations
CO4: The course will turn the students into skilled hands where they can contribute in various ways, either by pursuing their career in industry as a chemist or fulfilling their goals in academia by executing research projects</td></tr>
<tr><td>Examination Type</td><td colspan="8">Practical</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>20%</td><td>80%</td><td>0</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Practical</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">1. Viscosity:
(i) Determination of percentage composition of a liquid mixture by viscosity measurement.
(ii) Determination of molecular weight of a high polymer (say polystyrene) by viscosity measurement.
2. Surface Tension:
(i) Determination of Parachor value of $>CH_2$ group.
(ii) To measure interfacial tension and to test the validity of Antonoff’s rule.
(iii) To compare cleansing power of two detergents.
(iv) To determine the critical micelle concentration of a soap by surface tension method.</td><td></td></tr>
</table>

	3. Solubility: (i) Determination of solubility of an inorganic salt in water at different temperatures and hence to draw the solubility curve. (ii) To study the effect of addition of an electrolyte on the solubility of an organic acid. (iii) To study the variation of solubility of Ca $(OH)_2$ in NaOH solution and hence determine the solubility product. **4. Colloidal State:** (i) To compare the precipitation power of Na^+, Ba^{2+}& $A1^{3+}$ ions for As_2S_3 sol. (ii) To study interaction between arsenious sulphide and ferric hydroxide sol. **5. Density:** Determine the partial molar volume of ethanol in dil. aqueous solution at room temperature.	

Reference Books:

- **Levitt, B.P.** ***Findlay's Practical Physical Chemistry,*** 9th edition, Longman Group Ltd., 1973.
- **Matthews, G. Peter** ***Experimental Physical Chemistry,*** 1st edition, Oxford University Press, 1985.
- **Shoemaker, D.P.; Garland, C.W.; Nibler, J.W.** ***Experiments in Physical Chemistry***, 6th edition (International Edition) McGraw Hill Inc., 1996.
- **Khosla, B.D.; Garg, V.C. Gulati, A.** ***Senior Practical Physical Chemistry***, 11^{th} edition, R. Chand and Co., 2002.
- **Yadav, J. B.** ***Physical Chemistry Practical***,2015

Semester 3

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE601B	Core	Organic Chemistry-III	4	0	0	4
2	CHE602B	Core	Inorganic Chemistry-III	4	0	0	4
3	CHE603B	Core	Physical Chemistry-III	4	0	0	4
4	CHE604C	Core	Spectroscopy-II	4	0	0	4
5	CHE606B	Core	Inorganic Chemistry Lab-II	0	0	4	2
6	CHE607B	Core	Physical Chemistry Lab-II	0	0	4	2
7	CHE608B*	Elective	Seminar and Literature Survey	0	0	0	2*
8	CHE620B*	Elective	Advance Chemistry Lab-I	0	0	8	4*
9	Department Elective-I						4

	Total						**26/28***
Department Elective-I							
1	**CHE605B**	**Elective**	**Advanced Electrochemistry**	**4**	**0**	**0**	**4**
2	**CHE617B**	**Elective**	**Synthetic Organic Chemistry**	**4**	**0**	**0**	**4**
3	**CHE614B**	**Elective**	**Molecules of Life**	**4**	**0**	**0**	**4**
4	**PHY670**	**Elective**	**Nanoscience and Nanotechnology**	**4**	**0**	**0**	**4**

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Only 20 students in the class will be enrolled for research projects based upon their merit/performance in MSc first year. The students with research projects will study CHE608B of 2 credits and the others will study CHE620B of 4 credits in the third semester.

L: Lectures T: Tutorial P: Practical Cr: Credits

***Only 30 students in the class will be enrolled for research projects based upon their merit/performance in MSc first year. The students with research projects will study CHE608B of 2 credits and the others will study CHE620B of 4 credits in the third semester.**

Course Code	**CHE601B**
Course Title	**Organic Chemistry-III (Pericyclic Reactions and Photochemistry)**
Hours	60 L:4, T:0, P:0
Credits	4
Type	**Core**
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills:

<table>
<tr><td></td><td colspan="8">CO1: To understand the basic principle of pericyclic reaction and feasibility of Electrocyclic and cycloaddition reactions under photochemical and thermal conditions.
CO2: To understand the feasibility of sigmatropic reaction under photochemical and thermal conditions.
CO3: Understanding of basic principles of photochemistry; photochemical reactions of alkene and aromatic compounds
CO4: Understanding of photochemical reactions and mechanism of carbonyls.</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Pericyclic Reactions
Introduction, Construction of molecular orbitals and its symmetry in conjugated polyenes (ethylene, 1,3-butadiene, 1,3,5-hexatriene), & in conjugated ions and radicals (allyl, pentadienyl, and heptatrienyl system). Frontier molecular orbitals and theory of pericyclic reactions. Classification of pericyclic reactions and their complete description. Woodward-Hoffmann correlation diagrams of pericyclic reactions. Description of pericyclic reactions by Frontier molecular orbitals (FMO) and Perturbation molecular orbitals (PMO) methods. Electrocyclic reactions and its theory (conrotatory and disrotatory motions in 4n, 4n+2 and in conjugated ions and radicals). Cycloadditions reactions and its theory (stereochemistry, orientation effect, intermolecular,</td><td>CO1</td></tr>
</table>

	and intramolecular reactions)- antara facial and suprafacial additions in 4n and 4n+2 systems. 2+2 cycloaddition reactions, Chelotropic reactions and 1,3-dipolar cycloadditions reactions.	
	Unit 2: (15 hours) • **Sigmatropic rearrangements** Introduction, Classification of sigmatropic shift, Mechanism of sigmatropic shift reactions with FMO and PMO method. Sigmatropic shifts of hydrogen and carbon moieties (Suprafacial and antarafacial shift). [3,3] and [5,5] sigmatropic rearrangements and its stereochemistry. Cope rearrangement, Oxa-Cope rearrangement, Claisen rearrangement, and Aza-Cope rearrangement. Fluxional tautomerism or molecules. Intermolecular and intramolecular group transfer reactions (Ene reaction).	CO2
	Unit 3: (15 hours) • **Photochemical Reactions** Introduction and basic principles of photochemistry, electronic transitions, spin multiplicity. Types of excitations, the fate of excited molecule (Jablonski diagram), Description of physical processes. Photosensitization and quenching. Laws of Photochemistry. Quantum yield – actinometry, and its description. • **Photochemistry of Alkenes and Dienes** Photochemistry of alkenes: *Cis-Trans* isomerization and dimerization of alkenes. Photochemistry of conjugated dienes. • **Photochemistry of Aromatic Compounds** Photoisomerization of benzene and substituted benzene. Photoaddition of alkenes to aromatic benzenoid compounds. Photosubstitution of aromatic compound.	CO3

	Unit 4: (15 hours) • **Photochemistry of Carbonyl Compounds** α-Cleavage (Norrish type-I reaction) of acyclic saturated ketone, saturated cyclic ketone (cyclohexanones, cyclopentanones, cyclobutanones). β-cleavage reaction. Norrish type-II reaction. Intramolecular hydrogen abstraction (γ hydrogen abstraction). Intermolecular hydrogen abstraction (Photoreduction). Paterno-Buchi reactions. Cyclohexenone rearrangement (Lumiketone rearrangement and Di-π methane type rearrangement). Rearrangement of dienones. Photo rearrangement of α, β-unsaturated ketones (1,2-acyl shift and 1,3-acyl shift). Aza-Di-π methane rearrangement. Di-π methane rearrangement. • **Miscellaneous Photochemical Reactions** Rearrangement of aromatic compounds (Photo-Friesrearrangement). Photochemical oxidations. The Barton reaction. The Hoffmann-Loeffler-Freytag reaction. Photochemical formation of smog. Photochemistry of vision.	CO4

Reference Books:

- **Mukherji,S.M.** ***Pericyclic reactions***, Macmillan, 1979.
- **Turro, N.J. and Benjamin, W.A.** ***Molecular Photochemistry***, University Science Books, U.S., 1991.
- **Cox, A. and Camp, T.** ***Introductory Photochemistry***, McGrawHill, 1972.
- **Horsepool, W.M.** ***Organic Photochemistry***, Ellis Horwood, 1992.
- **Kalsi, P.S.** ***Organic Reactions and their Mechanisms***, New Age International, 2nd edition, 2000.
- **Singh, J and Singh, J:** ***Photochemistry and pericyclic reactions***, Revised 3rd edition, 2012.
- https://nptel.ac.in/courses/104106077/

Course Code	**CHE602B**
Course Title	**Inorganic Chemistry –III (Organometallics)**
Hours	60 L:4, T:0, P:0
Credits	4
Type	**Core**

<table>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:

CO1: In-depth knowledge on the advancement of organometallic compounds and their applications and to know how chemical properties are affected by metals and ligands.
CO2: be able to use knowledge about structure and bonding issues to understand the stability and reactivity of multiple-bonded organometallic complexes
CO3: Understanding and conceptualization of theory and applications of the reaction mechanisms and how to combine these to understand efficient catalytic processes. To know important applications of organometallic homogeneous catalysis in the production of chemicals.
CO4: To understand bioorganometallic Chemistry: fundamental concepts and mechanisms of organometallic poisoning, organometallic compound based medicine etc.</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Structure and Bonding
Organometallic chemistry: The 18 Valence Electron Rule: Introduction, 18 electron rule, counting of electrons and finding metal-metal bonds, Violation of 18 electron rule and related problems.
Ligands with Higher Hapticity: σ-bonded aryl ligands. Cyclic and acyclic polyenyl π-bonded ligands: Cyclopentdienyl (Cp-)</td><td>CO1</td></tr>
</table>

	ligands, Synthesis of Cp based sandwich compounds, Structure and properties of Cp_2M complexes, Reactions of other metal-sandwich compounds, Bent sandwich compounds, Schwartz reagent and hydrozirconation, Chemistry of Cp*, Chemistry of arene sandwich compounds. Allyl groups as ligands, 1,3-Butadiene complexes, Cyclobutadiene complexes, Cycloheptatriene and Cyclooctatetraene as ligands. Davies-Green-Mingos (DGM) rules.	
	Unit 2: (15 hours) • **Complexes with Metal-Carbon multiple bonds** Carbene and carbynes: Structure of Fischer and Schrock carbenes, synthesis of Fischer and Schrock carbene complexes. Tebbe's reagent and Petasis reagent Importance of metal carbene complexes. Structure, synthesis and properties carbyne complexes Neutral spectator ligand: Phosphines and N-Heterocyclic Carbene Metal clusters: binuclear and polynuclear, metal metal bond in low nuclearity and high nuclearity carbonyl clusters. Capping rule: limitation and exceptions of capping rule, polyhedral skeletal electron pair approach. Metal Clusters with main group elements, Jemmis' mno rules	**CO2**
	Unit 3: (15 hours) • **Applications of Organometallic Complexes to Catalysis** Catalysis, Thermodynamics of catalysis, Terminology in catalysis-turnover, turnover number, turnover frequency, enantioselectivity and regioslectivity of catalyst. Sequences involved in a catalyzed reaction, Heterogeneous catalysis, catalytic converter in automobiles. **Olefin metathesis**: A synthetic tool, olefin metathesis catalysts and properties. Synthesis of Grubbs and Schrock catalysts.	**CO3**

	Ring opening metathesis, cross metathesis, Ring closing metathesis, Ring opening metathesis polymerisation. **Catalytic hydrogenation**: classification of hydrogenation catalysts, catalytic cycle of iridium and ruthenium based catalysts, directing effects in catalytic hydrogenation, Hydrogenation by lanthanide organometallic compounds. Palladium catalyzed C-C and C-N coupling reactions: Heck reaction, Suzuki-Miyaura coupling, Sonogashira coupling, Negishi coupling, Buchwald-Hartwig C-N cross coupling.	
	Unit 4: (15 hours) • **Bioorganometallic Chemistry** Vitamin B_{12} coenzyme: discovery and structure, Role of organometallics in heavy metal poisoning: Mercury and Arsenic poisoning; organometallic compounds as drugs: ruthenium based anticancer drugs. Ferrocene based drugs: ferroquine and ferrocifen; Organometallic radiopharmaceutical, Organometallics tracers, ionophores and sensors.	**CO4**

Reference Books:

- **J.E. Huheey, Inorganic Chemistry, Principles of Structure and Reactivity**, Harper Inter-Science 4th edition.
- **B.D. Gupta and A.J. Elias, Basic Organometallic Chemistry**, Universities Press.
- **Organometallic Chemistry.** Third Edition. Gary O. Spessard and Gary L. Miessler.
- https://nptel.ac.in/courses/104108062/
- https://home.cc.umanitoba.ca/~budzelaa/CHEM4680/CHEM4680_lectures.html
- http://people.fas.harvard.edu/~chem253/

Course Code	**CHE603B**
Course Title	**Physical Chemistry III**
Hours	60 L:4, T:0, P:0

<table>
<tr><td>Credits</td><td colspan="8">4</td></tr>
<tr><td>Type</td><td colspan="8">Core</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:

CO1: Learn about need of quantum mechanics and understand the quantum chemistry with its importance in science
CO2: Understanding of quantum mechanical operators and mathematical function
CO3: To solve the wave function Ψ of different systems and quantum mechanical treatment of chemical bonding
CO4: Utilization of approximation methods
CO5: To understand the concept and importance of nanomaterials
CO6: To understand nuclear chemistry, its applications and uses of radioactive isotopes
CO7: To understand the concept of photochemistry and its use in various chemical and physical processes.</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Mathematical Preparation
Operators and observables, normality and orthogonally of functions, Hermitian operators.
Quantum Theory: Introduction and principles and applications</td><td>CO2</td></tr>
</table>

	Black Body radiation, Planck's radiation law, photoelectric effect, Compton effect, De-Broglie hypothesis, Heisenberg's uncertainty principle, eigenvalue equation, Hamiltonian operator, Interpretation of Ψ, Solution of particle in one, two and three dimensional box, degeneracy. Postulates of quantum mechanics, the linear harmonic oscillator, and the rigid rotator, Laddler operator method for angular momentum.	CO1 CO3
	Unit 2: (15 hours) • **The Approximation Methods** Need for approximation methods, Perturbation and Variation methods and their application to Helium atom. **Chemical Bonding** Chemical bonding, linear combination of atomic orbitals, overlap integral, coulomb integral, bond order, charge density calculations for ethylene, allyl system, butadiene system, cyclo butadiene, cyclo propenyl system.	**CO4**
	Unit 3: (15 hours) • **Nanochemistry** Properties of nanomaterials, General Method of synthesis, Characterization of nanomaterials, Material Self-assembly, Quantum dot, Nanoscale Materials, Fullerenes, Carbon nanotubes, nanowires, Nanorods, Dendrimers, Biological Nanomaterials, General Applications of Nanochemistry.	**CO5**
	Unit 4: (15 hours) • **Nuclear and Radiochemistry** Nuclear stability and binding energy, Mass and binding energy, Nuclear fission and nuclear fusion, fission cross section, chain fission, fission product and fission yield. Interaction of nuclear radiation with matter, **Photochemistry**	**CO6** **CO7**

	Difference between thermal photochemical reactions, laws of photochemistry, Jablonski diagram, qualitative description of fluorescence, phosphorescence, non- radiative processes (IC, ISC), quantum yield, photosensitized reactions, nuclear geometries of electronically excited states, Excimers and Exciplexes, kinetics of photochemical reactions, chemiluminescence.	

Reference Books:

- **Introduction to Quantum Chemistry,** A.K. Chandra, Tata McGraw Hill, 2017.
- **Quantum Chemistry**, I.M. Levine, Prentice Hall, 2016.
- **Essentials of Nuclear Chemistry**, , H.J. Arnikar, Wiley Eastern, New Delhi, 2011.
- **Nuclear & Radiochemistry,** G. Fridlander, J.W. Kennedy, E. S. Macias, and J. M. Miller, John Wiley, New York.
- **Quantum Chemistry**, R. K. Parsad,2010

Course Code	**CHE604C**
Course Title	**Spectroscopy -II**
Hours	60 L:4, T:0, P:0

<table>
<tr><td>Credits</td><td colspan="8">4</td></tr>
<tr><td>Type</td><td colspan="8">Core</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:

CO1: Understand the basic concepts and applications of NQR
CO2: Learn the theory and applications of Mossbauer Spectroscopy
CO3: Gain an understanding of fundamentals of EPR for investigation of paramagnetic species
CO4: Acquire knowledge of Photoelectron Spectroscopy
CO5: Grasp the concepts of Electron Microscopy</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Nuclear Quadrupole Resonance Spectroscopy
Introduction, experimental considerations, fundamentals of NQR spectroscopy, origin of EFG, measurement of energy differences between two nuclear spin states, the asymmetry parameter, effects of the magnetic field, interpretation of the spectra, application of the technique to halogen compounds, group elements, transition metals</td><td>CO1</td></tr>
<tr><td></td><td colspan="7">Unit 2: (15 hours)
• Mossbauer Spectroscopy
Experimental considerations, the spectrum and its parameters, simple spin states (I =1/2, 3/2), higher spin</td><td>CO2</td></tr>
</table>

	states (I > 3/2), magnetic splitting significance of parameters obtained from spectra, quadrupole splitting, additive model, interpretation of Mossbauer spectra of ^{57}Fe, ^{119}Sn.	
	Unit 3: (15 hours) • **Electron Paramagnetic Resonance Spectroscopy** Introduction, principle, Presentation of spectrum, hyperfine splitting in isotropic systems involving more than one nucleus, ESR spectrum of benzene radical anion, methyl radical, cyclopentadienyl radical, cycloheptatrienyl radical, pyrazine anion, pyrazine anion with ^{23}Na and ^{39}K counter ion and Nitrosyl nitroxide, Factors affecting magnitude of g values, zero field splitting and Krammer's degeneracy. EPR for characterization of Inorganic compounds.	**CO3**
	Unit 4: (15 hours) • **Photoelectron Spectroscopy** Introduction, photoelectron spectroscopy, chemical shift, X-ray photoelectron Spectroscopy, ESCA, ultraviolet photoelectron spectroscopy (UPS), exchange splitting and shake up process. • **Electron Microscopy** Optical microscopy, Scanning probe microscopy and Electron microscopy for characterization of Inorganic compounds	**CO4/CO5**

Reference Books:

- **Drago, R.S.** ***Physical Methods for Chemists***, 2nd Edition, 2016.
- **Silverstein, R.M. Bassler, G.C. and Morrill, T.C.** ***Spectrometric Identification of Organic Compounds***, Wiley, 8th Edition.
- **Kemp, W.** ***Organic Spectroscopy***, Macmillan, 3rd Edition, 2019.
- **Dyer, J. R.** ***Application of Absorption Spectroscopy of Organic Compounds***, Prentice Hall, 1978.

- **Williams, D. H. and Fleming, I.** ***Spectroscopic Problems in Organic Chemistry***, McGraw Hill, 6th Edition, 2007
- **Barrow, G.M.** ***Introduction to Molecular Spectroscopy***, McGraw Hill,1962.
- **Banwell, C.N.** ***Fundamentals of Molecular Spectroscopy***, McGraw Hill, 2017, 4th Edition.
- **Pavia, D.L., Lampan, G.M. and Kriz, G. S.** ***Introduction to Spectroscopy***, Hartcourt College Publishers, 5th Edition, 2013.
- **Parish, R.V. Spectroscopy in Inorganic Chemistry**,Ellis Horwood Limited, 1990

Course Code	**CHE606B**
Course Title	**Inorganic Chemistry Lab -II**
Hours	04 L:0, T:0, P:4
Credits	2

<table>
<tr><td>Type</td><td colspan="8">Core</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:

CO1: The course will turn the students into skilled hands where they can contribute in various ways, either by pursuing their career in the industry as a chemist or fulfilling their goals in academia by executing research projects.
CO2: The course will help them to understand the synthetic routes/methodologies to synthesize inorganic compounds.
CO3: The course will teach them the different spectroscopic methods to characterize synthesized inorganic compounds.</td></tr>
<tr><td>Examination Type</td><td colspan="8">Practical</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>20%</td><td>80%</td><td>0</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Practical</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">1 Preparation of mercury tetraisothiocyanatocobaltate (II). Determination of its magnetic moment and interpretation of its IR spectrum.
2 Preparation of nitro-and nitrito-pentaamminecobalt (II) chlorides from chloropentaamine cobalt (III) chloride. Recording and interpreting their electronic and IR spectra.
3 Heating the nitro and nitrito isomers at serial 2 to 15^{o}C in an oven for 3 h and recording the infrared spectra again and compare those with the spectra recorded before the isomers were heated.
4 Preparation and resolution of tris (ethylenediamine)cobalt(II) ion. Measurement of optical rotation of these resolved complexes.</td><td></td></tr>
</table>

	5 Preparation of diaquotetraacetatedicopper (II). Determination of its magnetic susceptibility and interpretation of E.P.R., electronic absorption and IR spectra. **6** Preparation of bis (2,4-pentanedione)vanadium(IV) acetate and its piperidine or pyridine complex. Study of both the complexes with the help of infrared, UV-vis spectroscopy and magnetic susceptibility. **7** Preparation of hexaamminenickel(II)chloride and tris(ethylenediamine)nickel(II) chloride. Interpretation of their electronic absorption spectral data and calculation of β and 10Dq values. Measurement of magnetic susceptibility, calculation and interpretation of the values. **8** Preparation of lead tetraacetate. **9** Preparation of potassium trioxalatoaluminate(III) trihydrate. Its TGA and DTA studies and its interpretation of its IR data. **10** Preparation of disulphur dichloride. **11** Preparation of sodium tetrathionate, potassium dithionate, and interpretation of their IR spectra. **12** Preparation of cis-and trans-potassium dioxalatodiaquochromate (III). Interpretation of their IR and selectronic absorption spectral data. Calculation of β and 10 Dq values. **13** Preparation of iron (II) oxalate and potassium trioxalateferrate(III). Interpretation of their magnetic data, E.P.R. and Mossbauer spectra. **14** Preparation of nitrosylbis-(diethyldithiocarbamato)iron(II) and interpretation of its IR and EPR spectra. **15** Preparation of chromium (II) acetate hydrate. **16** Preparation of Manganese (II) phthalocyanine. Interpretation of its IR, and electronic absorption spectra.	

Reference Books:

- **Marr, G. and Rockett, B.W.** ***Practical Inorganic Chemistry***, Van Nostrand Reinhold Company.
- **Jolly,W.L.** ***The Synthesis and Characterization of Inorganic Compounds***. Prentice Hall.

Course Code	**CHE607B**
Course Title	**Physical Chemistry Lab -II**
Hours	04 L:0, T:0, P:4
Credits	2
Type	**Core**
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills:

<table>
<tr><td></td><td colspan="8">CO1: The students will gain an understanding of the preparation for each experiment by studying lab handouts and links therein
CO2: The students will understand about safety requirements and lab skills to perform physico-chemical experiments
CO3: The students will learn how to keep records of instruments, parameters, and experimental observations
CO4: The course will turn the students into skilled hands where they can contribute in various ways, either by pursuing their career in industry as a chemist or fulfilling their goals in academia by executing research projects</td></tr>
<tr><td>Examination Type</td><td colspan="8">Practical</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>20%</td><td>80%</td><td>0</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Practical</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">1. Polarimetry:
To study the inversion of cane sugar by optical rotation measurement.
2. Potentiometry:
(i) Determination of valence of mercurous ion.
(ii) Determination of pH value using quinhydrone electrode.
(iii) Determination of heat of reaction, equilibrium constant and other thermodynamic functions for:
(a) $Zn + Cu^{+2}$ $Zn^{+2} + Cu$
(b) $Zn + Pb^{+2}$ $Zn^{+2} + Pb$
(iv) Determination of hydrolysis constant of aniline hydrochloride electrometrically.
3. Flame Photometry:
(i) Determination of Na^+ & K^+ when present together.</td><td></td></tr>
</table>

	(ii) Determination of Lithium/ Calcium/ Barium/ Strontium. **4. Transition Temperature Determination:** Determination of transition temperature of MnCl2 by Dielatometric method.	

Reference Books:

1. **Levitt, B.P.** ***Findlay's Practical Physical Chemistry***, 9th edition, Longman Group Ltd., 1973.

2. **Matthews, G. Peter** ***Experimental Physical Chemistry***, 1st edition, Oxford University Press, 1985.

3. **Shoemaker, D.P.; Garland, C.W.; Nibler, J.W.** ***Experiments in Physical Chemistry***, 6th edition (International Edition) McGraw Hill Inc., 1996.

4. **Khosla, B.D.; Garg, V.C. Gulati, A.** ***Senior Practical Physical Chemistry***, 11th edition, R. Chand and Co., 2002

Course Code	**CHE620B**
Course Title	**Advance Chemistry Lab-I**
Hours	08 L:0, T:0, P:8
Credits	2
Type	**Elective**
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills: **CO1: The students will gain an understanding of the preparation for each experiment by studying lab handouts and links therein**

<table>
<tr><td></td><td colspan="8">CO2: The student will get knowledge about common laboratory techniques including UV-Visible spectroscopy, IR spectroscopy, Thermogravimetric analysis, powder X-ray studies and scanning electron microscopy
CO3: The students will learn how to keep records of instruments, parameters, and experimental observations
CO4: The course will turn the students into skilled hands where they can contribute in various ways, either by pursuing their career in industry as a chemist or fulfilling their goals in academia by executing research projects</td></tr>
<tr><td>Examination Type</td><td colspan="8">Practical</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>20%</td><td>80%</td><td>0</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Practical</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Advance Inorganic Chemistry Lab
1. Synthesis of first row transition Metal complexes with reduced Schiff base ligands and their characterisation with various techniques, like UV-Visible spectroscopy, IR spectroscopy and Thermogravimetric analysis.
2. Synthesis of Cu (I) and Ag (I) salts with different counter anions and their characterization with IR spectroscopy.
3. Learning various methods of crystallisation (slow evaporation, layering, solvent diffusion, slow cooling, vapour diffusion and vacuum sublimation) and growing crystals of reduced Schiff base ligands and metal complexes as synthesised in steps 1 and 2.
4. Synthesis of ZnO and CdO nanoparticles and their characterization by powder X-ray studies and scanning electron microscopy.</td><td></td></tr>
</table>

	5. Study for the effect of Crystal field stabilization energy on the electronic spectra of transition metal complexes using UV-Visible spectroscopy. **Advanced Physical Chemistry Lab** 1. Understanding error, accuracy and precision by measuring physical parameters. 2. Determination of physical properties of materials 3. Advanced experiments involving chemical thermodynamics, chemical equilibria, chemical Kinetics, electro chemistry, spectroscopy, photochemistry and macromolecules. **Computational Chemistry Laboratory** Experiments involving optimization of molecular energies and geometries, calculation of thermodynamic parameters, kinetic parameters, prediction of spectral data.	

Reference Books:

- **Jolly,W.L.** ***The Synthesis and Characterization of Inorganic Compounds***. Prentice Hall.
- **Marr,G. and Rockett, B.W.** ***Practical Inorganic Chemistry***, Van Nostrand Reinhold Company.
- **Pass, G. and Sutcliffe, H** ***Practical Inorganic Chemistry:Preparations****, reactions and instrumental methods* , Springer Netherlan
- **Girolami, G. S., Rauchfuss, T. B., and Angelici, R. J.** ***Synthesis and Technique in Inorganic Chemistry: A Laboratory Manual*** **3rd Edition**, University Science Books
- **Svehla, G. and Sivasankar, B.** ***Vogel's Qualitative Inorganic Analysis (revised)***, Pearson, 7th edition, 1996
- **Halpern, A. M.; McBane, G. C.** ***Experimental Physical Chemistry: A Laboratory Prescribed Book,*** W. H. Freeman, 3rd edition, 2006.
- **Viswanathan, B.; Raghavan, P. S.;** ***Practical Physical Chemistry,*** Viva Books, 2010.
- **Hein, M.; Peisen, J. N.; Miner, R. L.;** ***Foundations of College Chemistry in the Laboratory***, John Wiley & Sons Inc., 2011.
- **Dave, R. K.;** ***Experiments in Physical Chemistry,*** Campus Books International, 2011.

- **J.B. Foresman, AEleen Frisch,** ***Exploring Chemistry with Electronic Structure Methods***, Gaussian, Inc., 2nd Ed., 2000
- **Frank Jensen,** ***An Introduction to Computational Chemistry***, John Wiley & Son Ltd., 1998.
- **Christoper Cramer,** ***Essentials of Computational Chemistry*****: Theories and Models**, John Wiley & Sons, 2002

Course Code	**CHE605B**
Course Title	**Advanced Electrochemistry**
Hours	60 L:4, T:0, P:0
Credits	4
Type	**Elective**
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills: **CO1: The students will gain an understanding of the electrochemistry of solutions I** **CO2: The student will get knowledge about electrochemistry of solution II** **CO3: The students will learn the Influence of various parameters, Hodges-Huxley equation, Nernst-Plank equation, H-electrode, polarography,**

<table>
<tr><td></td><td colspan="8">theory of Ilkovic eqn, (excluding derivation), Half wave potential & its significance, electrocardiography
CO4: The students will gain an understanding of corrosion and its control</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Electrochemistry of Solutions I
Ion-solvent interactions, the Born model, electrostatic potential at the surface of a charged sphere, Born expression for the free energy of ion-solvent interactions, structural treatment of ion-solvent interactions, ion-dipole moment, evaluation in the ion-dipole approach to heat of solvation, solvation number, static and dynamic pictures of ion-solvent interactions, hydration number, dielectric constant of water and ionic solutions, dielectric constant of liquids containing associated dipoles, ion – solvent nonelectrolyte interactions, change in solubility of non-electrolyte due to primary and secondary solvations.</td><td>CO1</td></tr>
<tr><td></td><td colspan="7">Unit 2: (15 hours)
• Electrochemistry of Solutions II
Debye-Huckel treatment, and its extension, ion solvent interaction, Debye-Huckel-Jerrum model, Thermodynamics of electrified interface equations, derivation of electro capillarity, Lippmann equations (surface excess), Methods of determining structures of electrified interfaces, Guoy-Chapman, Stern. Over potentials, exchange current density, derivation of Butler-volmer equation. Tafel plots. Quantum aspects of charge</td><td>CO2</td></tr>
</table>

	transfer at electrode solution interfaces, quantization of charge transfer, tunnelling Semiconductor interfaces- theory of double layer interfaces, effects of light at semiconductor solution interface.	
	Unit 3: (15 hours) • **Electro catalysis** Influence of various parameters, Hodges-Huxley equation, Nernst-Plank equation, H-electrode, polarography, theory of Ilkovic eqn, (excluding derivation), Half wave potential & its significance, electrocardiography	**CO3**
	Unit 4: (15 hours) • **Corrosion and its Control** Corrosion in Metal and alloys, causes of corrosion, Effects of Corrosion, Corrosion cell, Types of corrosion, Electrochemical corrosion, Corrosion control, Protective Coatings, Metal Finishing, Electroplating, Effect of plating variables on the Nature of Electro deposit, Surface preparation, Electroplating of Chromium, silver, Electro less plating.	**CO4**

Reference Books:

- **Electrochemistry,** S. Glasstone, Affiliated East-West Press.
- **Modern Electrochemistry**, J. O' M.Bockris & A.K.N. Reddy, Vol. II, A Plenum/Rosetta Edition.
- **Electrochemical methods,** Allen J. Bard, Wiley India.
- **Handbook of Electrochemistry**, Cynthia Zoski, Ist Ed., Elsevier.

Course Code	**CHE617B**
Course Title	**Synthetic Organic Chemistry**
Hours	60 L:4, T:0, P:0
Credits	4
Type	**Elective**
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills: **CO1: To understand the retro-synthesis of aromatic, alicyclic and aliphatic compounds and synthons & umpolung synthesis** **CO2: To understand the role of protecting groups in organic synthesis.** **CO3: To understand the reaction conditions, product formation and mechanism of rearrangement reactions**

<table>
<tr><td></td><td colspan="8">CO4: To study and analyze the fundamentals of bond disconnections and evaluate synthetic routes to target molecules using retrosynthesis.
CO5: To study the ring formation reactions, ring opening & closing, metathesis, 1,3 dipolar cycloaddition reaction.
CO6: To understand the disconnection approach and its applications towards synthesis of natural products</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
An introduction of synthesis and synthetic equivalents. General principle of disconnection approach; Importance of order of event in organic synthesis. Introductory meaning of one CX and two C-X groups disconnection. Reversal of polarity (umpolung), New application of organosilicone compounds, cyclization reactions of carbene and nitrenes.
Protective Groups: Principle of protection of alcoholic, amino, carbonyl and carboxylic groups with suitable examples from synthetic point of view.
Synthesis of alkene, β–elimination pyrolytic syn elimination, synthesis of allyl alcohol, sulphoxidesulphenate rearrangement, through phosphorous ylid, decarboxylation of β–lactum stereo selective synthesis of tri-tetra substituted alkenes through use of acetylenes. Use of nitro compounds in organic synthesis. Fragmentation of sulphonates, oxidative decarboxylation of carboxylic acids. Decomposition of toulene p-</td><td>CO1
CO2
CO3</td></tr>
</table>

	sulphonylhydrazones, stereospecific synthesis from – 1,2-diols. Stereoselective route to γ,δ–carbonyl compounds.	
	Unit 2: (15 hours) C-C bond formation: Generation and importance of enolate ion, regioselectivity, stereoselectivity. Generation of dianion and their alkylation, alkylation of relatively acidic methylene groups. Hydrolysis and decarboxylation of alkylated product, O-Vs-C alkylation, C-alkylation of vinyl group, aryl group. Formation of enamines and alkylation. Alkylation of carbon by conjugate additions. One group C-C - disconnection: Disconnection of simple alcohols, of simple olefins, carbonyl compounds control in synthesis, friedal craft's type examples.	CO4
	Unit 3: (15 hours) Reaction of carbon nucleophiles with carbonyl group: Condensation process favored equilibrium by dehydration of aldol products, under acidic and basic conditions, Amine catalysed condensation, Mannich Reaction, Nucleophilic addition, Cyclization process, Derzen, Perkin, Stobbe reaction. Sulphur slides, phosphorous ylides and related spices as nucleophiles. Diels Alder Reaction: General feature dienophile diene, intramolecular Diels Alder reaction stereochemistry and mechanisms, photo sensitized Diels Alder Reaction, homo Diels Alder reaction, ene synthesis, cycloaddition reaction of allyl cations/anions. Retro-Diels Alder's Reaction.	CO5
	Unit 4: (15 hours) Two Group Disconnections approach, 1,3-Difunctionalized compound -α-hydroxy carbonyl compounds. α, β-unsaturated carbonyl compounds, 1,3-di carbonyl compounds, α, β-unsaturated lactones 1,5-dicarbonyl compounds michael disconnection, use of Mannich Reaction in disconnection, Robinson's annelation.	CO6

	Synthesis of the following natural products using disconnection approach. Caryophyllene, Pencilline, Cephalosporin, 11-Oxoprogestrone, 11-Hydroxy progesterone, Aphidicaline and Juvabione.	

Reference Books:

- **Carruther, W.*Some Modern Method of Organic Synthesis***. Cambridge University Press, 1986
- **House,H. O.** ***Modern Synthetic Reactions***W. A. benjamin; 2nd edition, June 1972.
- **Finar, I. L.** ***Organic Chemistry***, Vol.2. Pearson publisher, 1956.
- **Norman, R.O.C, Coxon, J.M.** ***Principles of Organic Synthesis*** CRC Press, 3rd edition, September 1993.
- **Warren, S.** ***Organic Synthesis: The disconnection approach*** John Wiley, 2nd edition, Cambridge, 2008.
- **Michael C. Pirrung, Synthetic Organic Chemistry**, 2nd Edition, Elsevier.

Course Code	**CHE614B**
Course Title	**Molecules of Life**
Hours	60 L:4, T:0, P:0
Credits	4
Type	**Elective**
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills: **CO1: Classification and structural properties of carbohydrates** **CO2: Understanding of structure of Amino Acids, synthesis of peptides, and structures of Proteins; mechanical and kinetic property of enzyme**

<table>
<tr><td></td><td colspan="8">CO3: Biological importance of nucleic acids and lipids.
CO4: An advanced understanding of core principles and topics of metabolic processes and their biological reactions</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Carbohydrates
Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structures. Epimers, mutarotation and anomers. Determination of configuration of Glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.</td><td>CO1</td></tr>
<tr><td></td><td colspan="7">Unit 2: (15 hours)
• Amino Acids, Peptides and Proteins
Classification of Amino Acids, Zwitter ion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. Determination of Primary structure of Peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme).Synthesis of simple peptides (up to dipeptides) by</td><td>CO2</td></tr>
</table>

	N-protection (tbutyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis. • **Enzymes** Introduction, nomenclature and classification of enzymes, Mechanism of enzyme action, Specificity of enzyme action (Including stereo specificity), Enzyme kinetics, Michaelis-Menten equation, factors affecting enzyme action, Activators and Coenzymes (NAD, FAD and Acetyl coenzyme), cofactors and their role in biological reactions, Isozymes, Enzyme inhibition, role of enzymes in pharmaceuticals.	
	Unit 3: (15 hours) • **Nucleic Acids** Components of Nucleic acids, structure and functions of purines and pyrimidine bases, nucleosides and nucleotides, Base pairing, Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation. **Lipids** Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).	CO3
	Unit 4: (15 hours) • **Concept of Energy in Bio systems** Introduction to Metabolism (catabolism and anabolism), Carbohydrate metabolism (Glycolysis, Krebs cycle and fermentation). Protein metabolism, lipid metabolism, beta oxidation of fatty acids, Inter-relationships in the metabolic pathways of Proteins, Fats and Carbohydrates. Energy production through different metabolic processes (ATP	CO4

	production). Calorific value of food. Standard caloric content of carbohydrates, proteins and fats.	

Reference Books:

- **Morrison, R. T. and Boyd, R. N.** ***Organic Chemistry***, Pearson Education, 6th edition, 1992.
- **Finar, I. L.** ***Organic Chemistry*** **(Volume 1)**, Pearson Education, 6th edition, 1973.
- **Finar, I. L. Organic Chemistry (Volume 2),** Pearson Education, 6th edition, 1973.
- **Nelson, D. L. and Cox, M. M.** ***Menninger's Principles of Biochemistry***, W. H. Freeman 7th edition, 2004.
- **Berg, J. M., Tymoczko, J. L. and Stryer, L.** ***Biochemistry***, W. H. Freeman, 6th edition.
- **Russ Hodge, Molecules of Life: DNA, RNA and Proteins**.

Course Code	**CHE670B**
Course Title	**Nanoscience and Nanotechnology**
Hours	60 L:4, T:0, P:0
Credits	4
Type	**Elective**
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills: **CO1:** **CO2:** **CO3:**

<table>
<tr><td></td><td colspan="8">CO4:</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
Introductory Aspects: Free electron theory and its features, Idea of band structure - metals, insulators and semiconductors. Density of state and its variation with energy, Effect of crystal size on density of states and band gap. Electron confinement in one, two and two-dimensions, Nanostructures and its types, role of size, quantum confinement, surface to volume ratio, Size-dependent properties and applications, Single electron tunneling.</td><td></td></tr>
<tr><td></td><td colspan="7">Unit 2: (15 hours)
Preparation of Nanomaterials: Nucleation and growth of nanostructures: Homogenous and heterogeneous, Top down and bottom upapproaches, Chemical route: Chemical precipitation, Sol-gel, Microemulsions or reverse micelles, Solvothermal/hydrothermal, Electrochemical,Self-Assembly Monolayers (SAM), Physical routes - Inert gas condensation, Sputtering, Laser ablation, Ball Milling, Molecular beam epitaxy, Chemical and Molecular vapour deposition methods, Lithography.</td><td></td></tr>
<tr><td></td><td colspan="7">Unit 3: (15 hours)
Characterization Techniques: X-ray diffraction (XRD), determination of particle size, study of texture and microstructure, Scanning Electron Microscopy (SEM),</td><td></td></tr>
</table>

	Scanning Probe Microscopy (SPM) - Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM) Transmission Electron Microscopy (TEM), Optical characterization – UV-Visible, Photoluminescence, Vibrational spectroscopy, Magnetic resonance spectroscopy.	
	Unit 4: (15 hours) **Special Nanomaterials**: Carbon: nature of carbon bond; new carbon structures; Carbon clusters: small carbon clusters, structure of C_{60}, alkali doped C_{60}; Carbon nanotubes: fabrication, structure, electrical properties, vibrational properties, mechanical properties, application of carbon nanotubes: field emission and shielding, computers, fuel cells, chemical sensors, catalysis, Graphene – fabrication and properties	

Reference Books:

- **Chow, G.M. and Gonsalves, K.E.,** ***Nanotechnology - Molecularly Designed Materials,*** American Chemical Society (1996).
- **Jain, K.P., Physics of Semiconductor Nanostructures**, Narosa (1997).
- **Cao, G.,** ***Nanostructures and Nanomaterials: Synthesis, Properties and Applications***, Imperial College Press (2004).
- **B. D. Cullity,** ***Elements of X –ray Diffraction,Prentice Hall,***3rd edition (2001).
- **R.F. Egerton,** ***Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM*** F. Egerton, Springer (2005).
- **Nalwa,H.S.*Encyclopedia of Nanotechnology***, Springer (2012).
- **Bhusan, B.** ***Springer Handbook of Nanotechnology,*** Springer, 3rd edition (2010).

Semester 4

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE609B	Core	Organic Chemistry-IV	4	0	0	4
2	CHE610B	Core	Bio-Inorganic Chemistry	4	0	0	4
3	CHE612B*	Elective	Project	0	0	0	6*
4	CHE621B*	Elective	Advance Chemistry Lab-II	0	0	8	4*
5	CEC101	Core	Community Engagement Course	1	0	0	1
6	CEC102	Core	Community Engagement Field Activities	1	0	0	1
7	Departmental Elective			4	0	0	4
8	Departmental Elective			4	0	0	4
	Total						22*/24*

Departmental Elective (Choose any Two courses)							
1	**CHE611B**	**Elective**	**Bio-Physical Chemistry**	**4**	**0**	**0**	**4**
2	**CHE613B**	**Elective**	**Supramolecular Chemistry**	**4**	**0**	**0**	**4**
3	**CHE615B**	**Elective**	**Chemistry of Materials**	**4**	**0**	**0**	**4**
4	**CHE616B**	**Elective**	**Medicinal Chemistry**	**4**	**0**	**0**	**4**
5	**CHE618B**	**Elective**	**Advance Physical Chemistry**	**4**	**0**	**0**	**4**
6	**CHE619B**	**Elective**	**Analytical Techniques**	**4**	**0**	**0**	**4**

***The students with research projects will do Project work (CHE612B) of 6 credits and the others will study Advance chemistry Lab-II (CHE621B) of 4 credits in the fourth semester.**

Course Code	**CHE609B**
Course Title	**Organic Chemistry-IV (Chemistry of Natural Products)**
Hours	60 L:4, T:0, P:0
Credits	4
Type	**Core**
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills: **CO1: To understand the structure, stereochemistry, and synthesis of terpenoids and carotenoids** **CO2: To understand the structure elucidation and synthesis of alkaloids.**

<table>
<tr><td></td><td colspan="8">CO3: To study the classification, properties and synthesis of amino acids, peptides, and proteins.
CO4: To understand the stereochemistry and structure determination of steroids
CO5: To study the synthesis and biological importance of Vitamin, Porphyrins and Prostaglandins.</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Terpenoids and Carotenoids
General introduction, occurrence, methods of isolation and importance. Classification and nomenclature. Isoprene rule and Gem-dialkyl rule. Structure determination, stereochemistry and synthesis of the following representative molecules: citral, Terpeneol, Farnesol, santonin, phytol, Abietic Acid and Beta-Carotene, vitamin A.</td><td>CO1</td></tr>
<tr><td></td><td colspan="7">Unit 2: (15 hours)
• Alkaloids
Definition, occurrence, isolation, nomenclature, classification based on nitrogen heterocyclic ring, physiological actionand medicinal importance of alkaloids, general method of structure elucidation, degradation. Structure elucidation and synthesis of the following: Hygrine, Nicotine, Ephedrine, (+)- Conine, Atropine, Quinine and Morphine.
• Amino acids, Peptides and Proteins</td><td>CO2

CO3</td></tr>
</table>

	Introduction, amino acid classification and structure, general properties of amino acids and methods of synthesis. Classification of proteins, chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Solid phase peptide synthesis. Structure of proteins and forces responsible for holding protein structure	
	Unit 3: (15 hours) • **Steroids** Occurrence, nomenclature, basic skeleton. Diel's hydrocarbon. Stereochemistry and structure determination of cholesterol. Structure, biological importance and physiological effects of steroids, Vitamin D, Bile acids, Androgens, Oestrogens, Gestogens and Adrenocortical hormones. Synthesis of Cholesterol, Testosterone and Progesterone.	CO4
	Unit 4: (15 hours) • **Vitamins** Structure, synthesis and biological importance of Vitamin B complex, Vitamin C, Vitamin E and Vitamin K. **Porphyrins:** Structure, importance and synthesis of Haemoglobin and chlorophyll **Prostaglandins:** Occurrence, classification and physiological effects. Synthesis of PGE2 and PGF 2.	CO5

Reference Books:

- **Finar, I.L.** ***Organic Chemistry***, ELBS, Vol. 2, 5th edition, 1975.
- **Nogradi, M.** ***Stereoselective Synthesis: A Practical Approach***, VCH, 1995.
- **Coffey, S.** ***Rodd's Chemistry of Carbon Compounds***, Elsevier, 2nd Edition.

- **Hostettmann, Kurt, Gupta, M.P. and Marston, A.** ***Chemistry, Biological and Pharmacological Properties of Medicinal Plants,*** Americas, Harwood Academic Publishers.
- **Aggarwal, O.P.** ***Chemistry of Organic Natural Products****,* Vol. 1 & 2, Goel Publishing House, 2009.
- **Rohm, B.A.** ***Introduction to Flavonoids****,* Harwood Academic Publishers, 1998.
- **Rahman, A. and Choudhary, M.I.** ***New Trends in Natural Product Chemistry****,* Harwood Academic Publishers, 1998.
- **Dev, Sukh.** ***Insecticides of Natural Origin****,* Harwood Academic Publishers, 1997.
- **Mann, J. Davidson, R.S., Hobbs, J.B., Banthrope, D.V. and Harborne, J.B.** ***Natural Products:Chemistry and Biological Significance****,* Longman, Essex, 1994.
- https://www.sciencedirect.com/bookseries/studies-in-natural-products-chemistry

Course Code	**CHE610B**
Course Title	**Bio-Inorganic Chemistry**
Hours	60 L:4, T:0, P:0
Credits	4
Type	**Core**
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills:

<table>
<tr><td></td><td colspan="8">CO1: To know the function of metalloporphyrins of hemoglobin in oxygen binding by metal ions. know the structure and function of metalloenzymes and metalloproteins.
CO2: Understands the role of metal ions in photosynthesis, cobalamine B12 and the basic functions of living organisms. know how trace elements are involved in the basic functions of the body. recognize the applications of metal biomolecules in growth.
CO3: Basic understanding of the role of Inorganic Elements (metal, semimetal, nonmetal) in biological systems, understanding how metal ions interact with biological environments and how this interaction influences the properties of metal centers
CO4: Evaluate the applications of metal biomolecules as metallotherapeutic agents. know metal biomolecule’s applications as photoactive drugs. evaluate applications of metal biomolecules as diagnostic agents. know the applications of metal molecules in toxicology.</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Inorganic Chemistry of Enzymes - I
Introduction, energy sources for life, non-photosynthetic processes, metalloporphyrins, cytochromes, biochemistry of iron, iron storage and transport, ferritin transferring, bacterial iron transport, hemoglobin and myoglobin, nature of heme-dioxygen binding, model systems, cooperativity in hemoglobin, physiology of myoglobin and hemoglobin, structure and function of hemoglobin. Other iron-porphyrin</td><td>CO1</td></tr>
</table>

	biomolecules, peroxidases and catalases, cytochrome P450 enzymes, other natural oxygen carriers, hemerythrins, electron transfer.	
	Unit 2: (15 hours) • **Inorganic Chemistry of Enzymes - II** Respiration and photosynthesis (chlorophyll and photosynthetic reaction center); ferridoxins, and subredonim carboxypeptidase, carbonic anhydrase, Blue copper proteins, superoxide dismutase hemocyanines, Enzymes: Structure and function, inhibition and poisoning Vitamin B12 and B12 coenzymes metallothioneins, nitrogen fixation, in-vitro and in-vivo nitrogen fixation, bio-inorganic chemistry of Mo and W, nitrogenases: other elements V, Cr, Ni (essential and trace elements in biological systems).	**CO2**
	Unit 3: (15 hours) • **Metal Ions in Biological Systems** Biochemistry of dioxygen, bioinorganic chips and biosensors. Biochemistry of calcium as hormonal messenger, muscle contraction blood clotting, neurotransmitter, Metals in the regulation of biochemical events. Transport and storage of metal ions in vivo. Metal complexes as probes of structure and reactivity with metal substitution. Roles of Na^+, K^+, Mg^{2+}, Ca^{2+} and Ion pumps.	**CO3**
	Unit 4: (15 hours) • **Inorganic Medicinal Chemistry** Fundamentals of Toxicity and Detoxification, Nuclear med Chelation Therapy, Cancer Treatment, Anti-arthritis Drugs, I agents	**CO4**

Reference Books:

- **Huheey, J. E., Keiter, E. A. and Keiter, R.L. Inorganic Chemistry Principles of Structure and Reactivity**, 4 th edition, Haper Collins.
- **Douglas, B., McDaniel, D. and Alexander, J. Concepts and Models of Inorganic Chemistry**, John Wiley and Sons, 3rd edition.
- **Cotton, F.A. and Wilkinson, G. Advanced Inorganic Chemistry: A Comprehensive Text,** John Wiley, 5th edition.
- **Elschenbroich, Ch. and Salzer, A. Organometallics. A Concise Introduction**, VCH, 2nd edition.
- **Shriver, D.F. and Atkins, P.W. Inorganic Chemistry,** Oxford University Press, 3rd edition.
- **Cowan, J.A. Inorganic Biochemistry**, Wiley – VCH, 2nd edition.
- **Lippard, S. J. Progress in Inorganic Chemistry**, Vols. 18 and 38, Wiley-Interscience, 1991.
- **K. Hussain Reddy, Bioinorganic Chemistry**, New age International Limited, Publisher, 2007.

Course Code	**CHE621B**
Course Title	**Advance Chemistry Lab-II**
Hours	04 L:0, T:0, P:4
Credits	6
Type	**Elective**
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills:

<table>
<tr><td></td><td colspan="8">CO1: The students will gain an understanding of the preparation for each experiment by studying lab handouts and links therein
CO2: The student will get knowledge crystallization, structure elucidation of organic compounds by various techniques.
CO3: The students will learn how to keep records of instruments, parameters, and experimental observations
CO4: The course will turn the students into skilled hands where they can contribute in various ways, either by pursuing their career in industry as a chemist or fulfilling their goals in academia by executing research projects</td></tr>
<tr><td>Examination Type</td><td colspan="8">Practical</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>20%</td><td>80%</td><td>0</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Practical</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Advance Organic Chemistry Lab

• Spectroscopic identification of organic compounds and Chromatographic purification:
a. Identification of unknown organic compounds by interpretation of IR, UV, ^{1}H -NMR, ^{13}C NMR and mass spectral data. A minimum of 5 representative examples should be studied.
b. Thin layer chromatography: Determination of purity of a given sample, monitoring the progress of chemical reactions, identification of unknown organic compounds by comparing the R_f values of known standards.
c. Separation by column chromatography: Separation of a mixture using silica gel as adsorbent. Column</td><td></td></tr>
</table>

	chromatography should be monitored by TLC. • **Synthesis of organic molecules & isolation of natural products** **(A) Laboratory synthesis of the following compounds:** 2-Phenyl indole (Fischer indole synthesis), 7-hydroxy-3-methyl flavone (Baker – Venkatramanreaction), 2,5-Dihydroxy acetophenone (Fries reaction), 4- Chlorotoluene from p-toluidine (Sandmeyer reaction), Benzpinacol (photochemical reaction), 7-hydroxy coumarin (Pechman synthesis), Pictet-Spengler reaction, Photo-dimerization of maleic anhydride, benzophenone (Friedel-Crafts reaction), Vanillyl alcohol from vanillin ($NaBH_4$ reduction), Acridone from Phthalic anhydride. **(B) Isolation of the following natural products:** Caffeine from tea-leaves (solvent extraction), Eucalyptus oil from leaves (steam distillation), Lycopene from tomatoes. • **Protection/deprotection strategy of functional groups in organic synthesis:** Protection/deprotection of alcohol and amines in the synthesis of small organic molecules.	

Reference Books:

- **Harwood, L.M. and Moody, C.J.** ***Experimental Organic Chemistry****,* Blackwell Scientific Publishers, 1st edition, 1989.
- **Vogel, A.I.** ***Text Book of Practical Organic Chemistry,*** ELBS, Longman Group Ltd., 5thedition, 1978.
- **Mann, F.G. and Saunders, B.C.** ***Practical Organic Chemistry***, New Impression, Orient Longman Pvt. Ltd., 4th edition, 1975.
- **Leonard, J. and Lygo, B.** ***Advanced Practical Organic Chemistry****,* Chapman and Hall, 1995.

Course Code	**CEC101**
Course Title	**Community Engagement Course**
Hours	15 L:1, T:0, P:0
Credits	1
Type	**Core**
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills:

<table>
<tr><td></td><td colspan="8">CO1: To Develop an Appreciation of rural culture, life style and wisdom amongst students
CO2: 2. To learn about the status of various agricultural and rural development programmes
CO3: To understand causes for rural distress and poverty and explore solutions for the same
CO4: 4. To apply classroom knowledge of courses to field realities and thereby improve quality of learning</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>0</td><td>45%</td><td>0</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (4 hours)
• Appreciation of Rural Society: Rural life style, rural society, caste and gender relations, rural values with respect to community, nature and resources, elaborationof “soul of India lies in villages’ (Gandhi), rural infrastructure.
Teaching Methodology: Classroom Discussions
• Assignment: Prepare a map (physical, visual or digital) of the village you visitedand write an essay about inter-family relations in that village.
Mode of Assignment Submission: Written Assignment</td><td>CO1</td></tr>
<tr><td></td><td colspan="7">Unit 2: (5 hours)
• Understanding rural economy & livelihood: Agriculture, farming, landownership, water management, animal husbandry, non-farm livelihoods and artisans, rural entrepreneurs, rural markets</td><td>CO2</td></tr>
</table>

	Teaching Methodology: Group Discussions in Class • **Assignment:** Describe your analysis of rural household economy, its challengesand possible pathways to address them. **Mode of Assignment Submission:** Written Assignment	
	Unit 3: (4 hours) • **Rural Institutions:** Traditional rural organisations, Self-help Groups, Panchayati raj institutions (Gram Sabha, Gram Panchayat, Standing Committees), local civil society, local administration**.** **Teaching Methodology:** Classroom Discussions • **Assignment:** How effectively are Panchayati raj institutions functioning in the village? What would you suggest to improve their effectiveness? Present a case study (written or audio-visual). **Mode of Assignment Submission:** Group presentations of Assignment	**CO3**
	Unit 4: (4 hours) • **Rural Developmental Programmes:** History of rural development in India, current national programmes: Sarva Shiksha Abhiyan, Beti Bachao, Beti Padhao, Ayushman Bharat, Swatchh Bharat, PM AwaasYojana, Skill India, Gram panchayat Decentralised Planning, NRLM, MNREGA, etc. **Teaching Methodology:** Classroom Discussions • **Assignment:** Describe the benefits received and challenges faced in the deliveryof one of these programmes in the rural community; give suggestions about improving implementation of the programme for the rural poor. **Mode of Assignment Submission:** Written Assignment	**CO4**

Reference Books:

Books:

1. Singh, Katar, Rural Development: Principles, Policies and Management, Sage Publications, New Delhi, 2015.
2. A Hand book on Village Panchayat Administration, Rajiv Gandhi Chair for PanchayatiRaj Studies, 2002.
3. United Nations, Sustainable Development Goals, 2015 un.org/sdgs/
4. M.P.Boraian, Best Practices in Rural Development, Shanlax Publishers, 2016.

Journals:

1. Journals of Rural development, (published by NIRD & PR Hyderabad)
2. Indian Journal of Social Work, (by TISS, Bombay)
3. Indian Journal of Extension Education (by Indian Society of Extension Education)
4. Journal of Extension Education (by Extension Education Society)
5. Fostering Social Responsibility & Community Engagement in Higher EducationInstitutions in India
6. Kurukshetra (Ministry of Rural Development, GoI)
7. Yojana (Ministry of Information and Broadcasting, GoI)

Course Code	**CEC102**
Course Title	**Community Engagement Field Activities**
Hours	30 L:0, T:0, P:2
Credits	1
Type	**Core**

<table>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:
CO1:
CO2:
CO3:
CO4:</td></tr>
<tr><td>Examination Type</td><td colspan="8">Practical</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0%</td><td>0</td><td>50%</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Practical</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">The students are required to spend a total of 15 hours in field and select any 5 activitiesfrom among the following:

• Interaction with SHG women members, and study of their functions and challenges; planningfor their skill building and livelihood activities
• Visit MGNREGS project sites, interact with beneficiaries and interview functionaries at thework site
• Field visit to Swachh Bharat project sites, conduct analysis and initiate problem solvingmeasures
• Conduct Mission Antyodaya surveys to support under Gram Panchayat Development Plan(GPDP)
• Interactive community exercise with local leaders, panchayat functionaries, grass-root officials and local institutions regarding village development plan preparation and resource mobilization
• Visit Rural Schools / mid-day meal centres, study Academic and infrastructural resources andgaps</td><td></td></tr>
</table>

	• Participate in Gram Sabha meetings, and study community participation • Associate with Social audit exercises at the Gram Panchayat level, and interact withprogramme beneficiaries • Attend Parent Teacher Association meetings, and interview school drop outs Fostering Social Responsibility & Community Engagement in Higher Education Institutions in India • Visit local Anganwadi Centre and observe the services being provided • Visit local NGOs, civil society organisations and interact with their staff and beneficiaries, • Organize awareness programmes, health camps, Disability camps and cleanliness camps • Conduct soil health test, drinking water analysis, energy use and fuel efficiency surveys • Raise understanding of people's impacts of climate change, building up community's disasterpreparedness • Organise orientation programmes for farmers regarding organic cultivation, rational use ofirrigation and fertilizers and promotion of traditional species of crops and plants • Formation of committees for common property resource management, village pondmaintenance and fishing.	

Course Code	**CHE611B**
Course Title	**Bio-Physical Chemistry**
Hours	60 L:4, T:0, P:0
Credits	4

<table>
<tr><td>Type</td><td colspan="8">Core</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:
CO1: Developing of general understanding of how physical laws govern biological processes and understand the fundamental of biological macromolecules. Developing an understanding of the relation between structure, function, and dynamics of biological macromolecules.
CO2: To provide basic knowledge about the forces involved in biopolymer interactions, electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions, Hydrogen ion titration curves.
CO3: Acquire basic knowledge about the thermodynamics of biopolymer solution, cell membrane and transport of ions.
CO4: To make the students understand the different method for determining the molecular mass of the bio polymer and their optical properties.
CO5: Developing an understanding of different methods for the separation of biomolecules (Chromatography; Sedimentation, Moving Boundary Sedimentation, Zonal Sedimentation, Electrophoresis, Isoelectric focusing, Capillary electrophoresis, MALDI-TOF).</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Fundamentals of Biological Macromolecules
Biological Cell and its Constituents: Biological Cell, structure and functions of proteins, enzymes, DNA and RNA in living systems</td><td>CO1 & CO2</td></tr>
</table>

	Bioenergetics: Standard free energy change in biochemical reactions, exergonic, endergonic, Hydrolysis of ATP, synthesis of ATP from ADP, coupled reactions, degree of coupling. **Biopolymer Interactions**: Forces involved in biopolymer interactions, Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions, Hydrogen ion titration curves.	
	Unit 2: (15 hours) • **Thermodynamics of Biopolymer Solutions** **Biopolymer Solutions** Thermodynamics of biopolymer solutions, osmotic pressure, Donnan membrane equilibrium, muscular contraction and energy generation in mechano chemical system. **Cell Membrane and Transport of Ions** Structure and functions of cell membrane, Active transport across cell membrane, irreversible thermodynamics treatment of membrane transport.	**CO3**
	Unit 3: (15 hours) • **Structural Determination of Biological Macromolecules** **Bio-polymers and their Molecular Weights** Evaluation of size, shape, molecular weight and extent of hydration of biopolymers by various experimental techniques. **Viscosity** Measurement, relation to geometry and correlation with hydrodynamic properties. **Diffusion** Fick's Law of diffusion, diffusion coefficient and its interpretation, frictional coefficient. **Ultracentrifugation:** Svedberg equation, sedimentation equilibrium, density gradient sedimentation. **Osmotic Pressure**	**CO4**

	Second virial coefficient, Determination of Molecular weight of bio polymers **Optical Properties of Biomacromolecules** Light Scattering, fundamental concepts, Rayleigh Scattering, Scattering by Larger particles.	
	Unit 4: (15 hours) • **Methods for the Separation of Biomolecules** General principles, including Chromatography; Sedimentation, Moving Boundary Sedimentation, Zonal Sedimentation, Electrophoresis, Isoelectric focusing, Capillary electrophoresis, MALDI-TOF.	**CO5**

Reference Books:

- **Principles of Biochemistry**, A.L. Lehninger, Worth Publishers, 2013.
- **Biochemistry**, L. Stryer, W.H. Freeman, 2011
- **James P. Allen, Biophysical Chemistry**, a John-Willey and Sons Publications,2008.
- **Biochemistry,** Voet and Voet, John Wiley, 2012
- **Macromolecules: Structure and Function**, F.Wold., Prentice Hall.
- **Text Book of Polymer Science**, F.W. Billmeyer, 2007
- **Physical Chemistry of Polymers**, A. Tager.
- **Biophysical Chemistry**, Vol. 1-3, C. R. Cantor & Schimmel
- **Physical Biochemistry: Applications to Biochemistry and Molecular Biology** by D. M. Freifelder
- **Biophysical Chemistry: Principles and Techniques** by A. Upadhyay, Himalaya Publishing House, 2016.

Course Code	**CHE613B**
Course Title	**Supramolecular Chemistry**
Hours	60 L:4, T:0, P:0
Credits	4
Type	**Core**

<table>
<tr><td>Course Outcomes</td><td colspan="8">On the completion of the course, the student will gain the following knowledge and skills:
CO1: To understand the fundamental basis of intermolecular interactions and illustrate how these can be exploited to form diverse supramolecular assemblies ranging from small molecules, soft gels, and hard extended inorganic solids.
CO2: To understand non-covalent interactions, molecular recognition and self-assembly and how these can be exploited to prepare functional molecules and materials for a wide range of applications.CO3: To understand the role of supramolecular chemistry in our daily life and Pharmaceutical Industry, chemical biology, materials science, and nanotechnology.
CO4: Have an appreciation of the significance and application of supramolecular chemistry, including in materials chemistry biological systems, pharmaceutical products, and the controlled construction of nanoscale entities.</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory/ Practical</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory/ Practical</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Concepts
Definition and Concepts of supramolecular chemistry.Development of Supramolecular Chemistry. Various types of non-covalent interactions (Hydrogen bonds, π-π interactions, cation-π interactions, Closed shell interactions, solvation and hydrophobic effects, Van der Waals interactions.</td><td>CO1</td></tr>
</table>

	Macrocyclic and macro-bicyclic effect, template effect (illustrated by acyclic, macrocyclic and macropolycyclic ligand systems), supramolecular Host-Guest chemistry, Lock and Key Analogy. Binding constant and measurement of binding constant. Cooperativity and chelate effect, molecular and chiral recognition, pre-organization and complementarity, concept of induced fit, allosteric effect.Concept of host design.	
	Unit 2: (15 hours) • **Crystal Engineering** Concept of crystallization and crystal engineering. Supramolecular tectones and synthons, Mechanochemistry and Topochemistry, Graph Set analysis, CSD database of CCDC. **Polymorphism:** Definition and occurrence, thermodynamic and kinetic relationships of the formation of polymorphs, Methods of polymorph characterization, properties of polymorphs, case studies from the pharmaceutical industry. **Co-crystals/Multi-component crystals:** classification, definition and nomenclature, solid solutions, Host-Guest compounds, solvates and hydrates, Donor-Acceptor complexes, co-crystals of pharmaceutical importance.	**CO2**
	Unit 3: (15 hours) • **Supramolecular Host** **Cation Binding** Crown ethers: Discovery, Scope and Synthesis, Conformational Characteristics of Crown Ethers, Donor Group Orientation and Chelate Ring Size Effects, Cation Binding by Crown Ethers, Solution Applications of crown ethers. Lariat ether, Bibracchial Lariat Ethers, and Podands: Cation Binding by Lariat Ethers. Cryptands: Discovery, Scope and Synthesis, Cation Binding by Cryptands, Sepulchrates and sarcophagenes Spherands: Discovery, Scope and Synthesis,	**CO3**

	Ditopic Receptors,Chiral Recognition, Amphiphilic Receptors, TheSiderophores The calixarenesCation Complexation by Calixarenes **Anions Binding** Anions in environment, challenges in designing anion binding host, Guanidinium-based receptors, Neutral receptors, organometallic receptors **Neutral Molecular Binding** Cyclodextrin: Introduction and Properties**,** Preparation, Inclusion Chemistry, Industrial Applications **Molecular Clefts and Tweezers** Cyclophene: General Aspects, Cyclophane Nomenclature, Cyclophane Synthesis **Carcerands and Hemicarcerands:** Definitions and Synthesis	
	Unit 4: (15 hours) • **Applications of Supramolecular Chemistry** **Network Solids: What Are Network Solids?** Concepts and Classification, Network Topology, Porosity **Inorganic Porous Materials: Zeolites -** Composition and Structure, Synthesis, MFI Zeolites in the Petroleum Industry **Inorganic-Organic Hybrid materials:** Coordination Polymers, Metal Organic Frameworks Definition, classification and design strategies, network topologies, interpenetration, properties and applications. **Catenanes and Rotaxanes:** Overview, Statistical Approaches to Catenanes and Rotaxanes, Molecular Necklaces **Molecular Knots:** The Topology of Knots, Trefoil Knots, Borromean Rings **Molecular Devices and Molecule-Based Electronics:** Molecular Electronic Devices, Molecular Wires, Molecular Switches **Liquid Crystals:** Nature and Structure, Design of Liquid Crystalline Materials, Supramolecular Liquid Crystals	**CO4**

	Supramolecular Gels: concept, types, properties, and applications	

Reference Books:

- **Steed, J. W. and Atwood, J. L. *Supramolecular Chemistry***, Wiley: Chichester, 2000.
- **Ariga, K. and Kunitake, T. *Supramolecular Chemistry***: *Fundamentals and Applications*, Springer, Berlin, 2005.
- **Steed, J. W., Turner, D. R. and Wallace, K. J. *Core Concepts in Supramolecular Chemistry and Nanochemistry,*** Chichester, Wiley, 2007.
- ***Frontiers in Crystal Engineering*** *by E.R.T. Tiekink, J.J. Vittal*
- *https://nptel.ac.in/courses/104103018/module1/lec4/2.html*
- *https://www.internetchemistry.com/chemistry/supramolecular-chemistry.php*
- *https://nptel.ac.in/courses/112106227/*
- *https://iversity.org/en/courses/the-fascination-of-crystals-and-symmetry*
- *https://www.facebook.com/crystalmooc/*

Course Code	**CHE615B**
Course Title	**Chemistry of Materials**
Hours	60 L:4, T:0, P:0
Credits	4
Type	**Core**
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills:

<table>
<tr><td></td><td colspan="8">CO1: To understand the fundamental basis of Solid-State Chemistry
CO2: To understand the basic concept of macromolecules and the methods for the determination of molecular weight of macromolecules.
CO3: To understand the role of glass and ceramics.
CO4: Have an appreciation of the significance and application of smart lab, including their fabrication methods</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Solid State Chemistry
Types of solids, band and bond theories, crystal lattice energy, point defects in metals and ionic compounds, energy and entropy of defects, their concentration, diffusion and electrical conduction via defects, non-stoichiometry types, colour centres and electrical properties of alkali halides, electron theories for metal conduction in metals , in insulators, impurity semi-conductors, reactions in organic solids, photochemical reactions, solid-solid reactions, decomposition and dehydration reaction.</td><td>CO1</td></tr>
<tr><td></td><td colspan="7">Unit 2: (15 hours)
• Macromolecules
Types of polymers, regular and irregular polymers, synthesis of polymers by chain and step reactions, physical properties of solid polymers(crystallinity, plasticity and elasticity), vulcanization of rubbers, molecular mass determination by osmometry, viscometer, light scattering and ultracentrifuge</td><td>CO2</td></tr>
</table>

	methods, number and mass average molecular masses, polymer solutions, factors affecting the solubility of polymers , conducting polymers, doping of polymers, mechanism of conduction, polarones and bipolarons.	
	Unit 3: (15 hours) • **Glasses and Ceramics** Factors affecting glass formation, oxide glasses, electronegativity and bond type, viscosity, structural effects (zachariasen's rule (1932), criteria of SUN and Rawson, thermodynamics of glass formation, behavior of liquids on cooling, kinetics of crystallization and glass formation, structure of glasses: vitreous silica, silicate glasses, vitreous B_2O_3 and borate glasses, viscosity, electrical conductivity of glasses and the mixed alkali effect, commercial silicate and borate glasses, metallic glasses , glass ceramics, refractories, important glass-ceramics compositions, properties of glass ceramics, applications.	**CO3**
	Unit 4: (15 hours) • **Smart Materials** Methods of preparation- conventional ceramic methods, hot pressing and hot static pressing techniques, precursor method, gel method, co-precipitation method, glass crystallization methods, vacuum techniques- chemical vapor deposition method, organic superconductors, magnetism in organic materials, magnetic nanomaterials, energy storage materials, nanomaterials for targeted drug delivery, fullerenes as superconductors. High temperature ceramic superconductors, electrical and magnetic properties of superconductors, critical temperature Tc, thermodynamics of superconductors, London equation, BCS theory, applications.	**CO4**

Reference Books:

- **Cornell,P. J. Flory.*Principles of polymer chemistry***, University Press.
- **Tager,A. J.*Physical chemistry of polymers***, Mir Publishers.
- **Dekker,A. J.*Solid state physics***, MacMillan Publishers.
- **West,A. R.*Solid state chemistry and its applications***, Wiley Publishers.
- **Puri, Sharma and Pathania*, Principles of physical chemistry***, Vishal Publishers.
- **Gray,G. W.*Thermotropic Liquid crystals***, John Wiley.
- **Malcolm, P and Stevens, *Polymer Chemistry***, Oxford University Press.
- **Keer, H. V. *Principles of Solid States***, Wiley Eastern.

Course Code	**CHE616B**
Course Title	**Medicinal Chemistry**
Hours	60 L:4, T:0, P:0
Credits	4
Type	**Core**
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills: **CO1: To understand the fundamentals of enzymes and their action of mechanism**

<table>
<tr><td></td><td colspan="8">CO2: To understand the basic concepts of kinetics of reactions catalyzed by enzymes.
CO3: To understand the fundamental of co-enzymes chemistry
CO4: Gain the knowledge of manufacturing of different drugs design</td></tr>
<tr><td>Examination Type</td><td colspan="8">Theory</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>LP</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>10%</td><td>25%</td><td>0</td><td>50%</td><td>0</td><td>0</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="7">Theory</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="7">Unit 1: (15 hours)
• Enzymes
Basic considerations. Proximity effects and molecular adaptation. Introduction and historical prospective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer’s lock and key and koshland’s induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labelling and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michaelis-menten and lineweaver-Burk plots, reversible and irreversible inhibition.
• Mechanism of Enzyme Action
Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonucleases, lysozyme and carboxypeptidase A.</td><td>CO1</td></tr>
<tr><td></td><td colspan="7">Unit 2: (15 hours)
• Kinds of Reaction Catalysed by Enzymes</td><td>CO2</td></tr>
</table>

	Nucleophilic displacement on a phosphorus atom, multiple displacement reaction and the coupling of ATP cleavage to endergonic processes. Transfer of sulphates, addition and elimination reactions, enolic intermediates in isomerization reactions, β-cleavage and condensation, some isomerisation and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation.	
	Unit 3: (15 hours) • **Co-Enzyme Chemistry** Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological function of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN, FAD, LIPOIC ACID, vitamin B12. Mechanisms of reactions catalysed by the above cofactors.	**CO3**
	Unit 4: (15 hours) • **Drug Design** Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrugs and soft drugs, structure-activity relationship (SAP), factors affecting bioactivity, resonance, inductive effect, isosterism, bio-isosterism, spatial considerations. Theories of drug activity: occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship. History and development of QSAR. Concepts of drug receptors. Elementary treatment of drug receptors interactions. Physico-chemical parameters: lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton and surface activity parameters and redox potentials. LD-50, ED-50 (Mathematical equations excluded)	**CO4**

Reference Books:

- **Lehninger,** ***Principles of Biochemistry***,WH-Freeman, 5th edition.
- **Silverman, R. B.** ***The organic chemistry of drug design and drug action***, Academic press 2nd edition, 2004.
- **PandeyaS. S. and Dimmock,J.R.** ***An introduction to drug design***, New Age International.

Course Code	**CHE618B**
Course Title	**Advanced Physical Chemistry**
Hours	60 L:4, T:0, P:0
Credits	4
Type	**Core**
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills: **CO1: To understand the concept of surfactant aggregation.** **CO2: To understand the basic concept of kinetics of polymerization and Statistics of Linear Polymer Chains** **CO3: To understand the Thermodynamics of Macromolecular Solutions and acquire the knowledge of Characterization of Macromolecules by different methods** **CO4: Acquire the knowledge of different kinds of nanomaterials, their synthesis methods and their characterizations by different methods**
Examination Type	Theory

Assessment Tools	Written Quiz	Assignment/Project Work	MSE	MSP	ESE	LP	ESP	ABL/PBL
Weightage	**10%**	**10%**	**25%**	**0**	**50%**	**0**	**0**	**5%**
Examination Mode	Theory							
Syllabus	**Unit 1: (15 hours)** • **Surfactant Aggregation** Micelles, Surface active agents, Classification of surface active agents, Micellization,Hydrophobic interaction, Critical micellar concentration (cmc), Factors affecting theconcentration of surfactants, Counter-ion binding of micelle, Thermodynamics ofmicellization, Phase separation and Mass action models, Solubilization Emulsions, Mechanism of formation of microemulsion and their stability, Phase maps, Physical techniques, Applications.							CO1
	Unit 2: (15 hours) **Introduction** Macromolecular concept. Molar mass averages, distribution of molecular mass. **Kinetics of Polymerizaton** Kinetics of step growth polymerization, size distribution in linear polymers. Kinetics offree radical addition polymerization, distribution of molar masses, effect of temperature.Ionic polymerization, kinetics of cationic and anionic polymerization. **Statistics of Linear Polymer Chains** Polymer chain flexibility and internal rotation, random flight analysis of end-to enddistance for freely jointed chain in one dimension and three dimensions. Effect of bondangle and restricted rotation on chain dimensions. Unperturbed chains. Long-rangeinteractions and effect of solvent. Distribution of chain segments relative to centre ofmass.							**CO2**

	Unit 3: (15 hours) • **Thermodynamics of Macromolecular Solutions** Flory-Huggins theory. Flory-Krigbaum theory of dilute solutions, partial molarquantities.Osmotic pressure. • **Characterization of Macromolecules** Flow properties, generalized flow equation. Frictional co-efficient and flow properties.Determination of molecular size and mass from diffusion, sedimentation velocity,sedimetation equilibrium and viscosity. Light scattering and small angle X-ray scattering.	**CO3**
	Unit 4: (15 hours) • **Nanomaterials**: Definition, historical perspective and effects of nanoscience and nanotechnology onvarious fields. Synthesis of nanoparticles by chemical routes and characterizationtechniques: Thermodynamics and kinetics of nucleation; Growth of polyhedral particlesby surface reaction, Ostwald ripening, size distribution; TEM; SEM; AFM; Lightscattering; XPS. Properties of nanostructured materials: Optical properties; magneticproperties; chemical properties. Overview of applied chemistry of Nanomaterials.	**CO4**

Reference Books:

- **Young R.J. and Lovell P.A.,** ***Introduction to Polymers***, Pubs: Chapman and Hall,London, 2nd ed., New Delhi (2004).
- **Billmeyer F.W. Jr.,** ***Text book of polymers science***, Pubs: Wiley-Interscience, 3rdedn.,(1984).
- **Myers D.,** ***Surfactant Science and Technology***, Pubs: VCH Publishers (1988).
- **Flory P.J.,** ***Principles of polymer chemistry***, Pubs: Cornell Univ. Press, Ithace (IndianPrint 2006).
- **Tager A,** ***Physical Chemistry of polymers***, Pubs: Mir Publishers, Moscow (1971).

- **R.J.,** ***Foundations of Colloid Science,*** Vols. I & II, Pubs: Oxford Science Publications(1989).

Interdisciplinary Courses:

S.No	Paper Code	Course Title	L	T	P	Cr
1	CSA555	FUNDAMENTALS OF COMPUTERS AND PROGRAMMING USING C	3	0	0	3
	CSA556	FUNDAMENTALS OF COMPUTERS AND PROGRAMMING USING C Lab	0	0	2	1
2	EVS051	Dynamics of Biogeography	4	0	0	4
3	EVS052	Green Technology	4	0	0	4
4	EVS053	Environmental Toxicology	4	0	0	4
5	BOT505	Forestry	4	0	0	4
6	BOT535	Conservation of Natural Resources	4	0	0	4
7	ENG531	Writing Skills	4	0	0	4
8	ENG532	Creative Writing	4	0	0	4
9	ENG533	Living Literature	4	0	0	4
10	MIC006	Fermentation Microbiology	4	0	0	4
11	MIC007	Microbiology of Diseases	4	0	0	4
12	MGT051	Business Strategy	4	0	0	4
13	MGT052	Principles of Marketing	4	0	0	4
14	MGT053	Research Methodology	4	0	0	4

15	**CHE615B**	**Chemistry of Materials**	**4**	**0**	**0**	**4**
16	**CHE616B**	**Medicinal Chemistry**	**4**	**0**	**0**	**4**
17	**MTH 636**	**Discrete Mathematics**	**4**	**0**	**0**	**4**
18	**MTH 633**	**Operational Research**	**4**	**0**	**0**	**4**
19	**MTH580**	**Mathematics for Chemists**	**4**	**0**	**0**	**4**
20	**ZOO701**	**Biology for Chemists**	**4**	**0**	**0**	**4**