S.K.C.G. (AUTONOMOUS) COLLEGE

PARALAKHEMUNDI,GAJAPATI-761200

COURSES OF STUDIES

Choice Based Credit System (CBCS)

M. Sc. - Chemistry

2020-21 AND ONWARDS

DISTRIBUTION OF MARKS

End Semester Examination

Full Marks:80

SECTION-A 08 Short Answer Questions (SAQ) (50 words) out of 12 Questions covering the entire Syllabus.	08x02 = 16 marks
SECTION-B 04 Short Answer Questions (SAQ) (100 words) each Question with one alternative set unit wise.	04x04 = 16 marks
SECTION-C* 04 Long Answer Questions (LAQ) (500 words) each Question with one alternative set unit wise.	04x12 = 48 marks
	Total → 80 marks

***SECTION – C**

Q.No.2- **Unit-I**	LAQ (Answer any one Question) a. b.	01x12 = 12 marks
Q.No.3- **Unit-II**	LAQ (Answer any one Question) a. b.	01x12 = 12 marks
Q.No.4- **Unit-III**	LAQ (Answer any one Question) a. b.	01x12 = 12 marks
Q.No.5- **Unit-IV**	LAQ (Answer any one Question) a. b.	01x12 = 12 marks

General Course Framework & Structure
(M. Sc. Chemistry)

SEMESTER- I: Total Credits/Total core/electives (20/05/00); Total marks: 500.

Course Number	Coursed Name	Mark		Credit
		Mid sem	End sem	
CHE 101	Organic Chemistry-I	20	80	4
CHE 102	Inorganic Chemistry-I	20	80	4
CHE 103	Physical Chemistry-I	20	80	4
CHE 104	Physical Spectroscopy	20	80	4
CHE 105	Organic Practical	100		4

SEMESTER-II: Total Credits/Total core/electives (20/05/00); Total marks: 500.

Course Number	Coursed Name	Mark		Credit
		Mid sem	End sem	
CHE 206	Organic Chemistry-II	20	80	4
CHE 207	Inorganic Chemistry-II	20	80	4
CHE 208	Physical Chemistry-II	20	80	4
CHE 209	Organic Spectroscopy	20	80	4
CHE 210	Inorganic Practical	100		4

SEMESTER- III: Total Credits/Total core/electives (20/02/03*); Total marks: 500.

Course Number	Coursed Name	Mark		Credit
		Mid sem	End sem	
CHE 311	Analytical Chemistry	20	80	4
CHE 312	Organic Synthesis	20	80	4
CHE 313	Organometallic Chemistry	20	80	4
CHE 314	Environmental Chemistry	20	80	4
CHE 315	Physical & Analytical Practical	100		4

SEMESTER-IV: Total Credits/Total core/electives (20/03/02); Total marks: 500.**

Course Number	Coursed Name	Mark		Credit
		Mid sem	End sem	
CHE 416	Organic Chemistry-III	20	80	4
CHE 417	Physical Chemistry-III	20	80	4
CHE 418	Bio-organic Chemistry	20	80	4
CHE 419	Polymer Chemistry	20	80	4
CHE 420	Dissertation	100		4

(CHEM: Chemistry, C: Core , P: Practical & D: Dissertation).

SEMESTER-I

Semester: I **Credits: 4 (core)**

Course No. **CHE-101**

Course Name: **Organic Chemistry-I**

Pre-requisites: B.Sc. (Hons.) Organic Chemistry

Objective and brief description on course and expectations: This course gives the basics of organic chemistry with an in-depth understanding of a broad range of basic organic reactions such as substitution, addition-elimination reactions, fundamental prospective such as idea of reaction intermediates, drawing reaction mechanism, name reactions-rearrangement, organic photochemistry, understanding stereochemistry with conformations.

Course Details:

Chapter/ Unit	Contents	Hours/ Semester
1	**Basics concept of Organic chemistry**: Aromaticity: aromatic, non-aromatic and anti-aromatic nature of compounds. pKa of organic molecules, Regioselective, Stereospecific, Stereoselective and Chemoselective reactions. Reactive intermediates formation and mechanism (carbocation, carbanion, carbene, nitrene, free-radical, Benzyne). HSAB principle, NGP, Classical and non-classical carbocations, Bredt's rule. **Substitution, Elimination & free radical reactions**: SN_1, SN_2, SN_i, SN_2', $SArN_1$, $SArN_2$, SE_1, SE_2, SEi. E_2, E_1, E_1CB, Pyrolytic elimination, Von Richter, Sommelet-hauser, and Smiles rearrangements. Allylic halogenation (NBS), coupling of alkynes, aromatic compounds by diazonium salts, Sandmayer reaction. Stereoselctive synthesis of alkene by elimination reactions.	14
2	**Addition to C-C & C-X (heteroatom) multiple bonds:** Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselecticvity, orientation and reactivity. Hydroboration, Oxymercuration, Epoxidation (selective), Sulfonium Ylides, Halohydrin addition. Michael reaction. Wackers oxidation, Chemo- and Stereoselctive reactions, Stereospecific reaction aspect of carbonyls and double/triple bond. **Organic Photochemistry**: Electronic excitation, Jablonski diagram & Fluorescence- Phosphorescence. Photo isomerization, Photo-dissociation reactions: Norrish Type-I & II cleavage, Photo-Fries rearrangement, Paterno-Buchi reaction, Barton reaction, Hofmann-Loffler-Freytag reaction, Di-Pi methane rearrangement. Photo-Oxidation of alkenes, Photochemistry of vision, Photochemistry of aromatic compounds.	16
3	**Name Reactions & rearrangement:** Bayer-Villiger, Baylis–Hillman, Knoevenagel, Claisen condensation, Stobbe condensation, Clasien-Schmidt, Shapiro reaction, Mannich, Benzoin, Perkin and Stobbe, Wittig, Vilsmeier-Haack, Hunsdiecker, Robinson annulations, Stork-enamine, Michael addition, Fisher-Indole Synthesis, Hantzsch Pyridine Synthesis, Chichibabin reaction. Nature of migration, migratory aptitude. Pinacol-Pinacolone, Wagner-	14

	Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hofmann, Curtius, Schmidt, Lossen rearrangement and Steven rearrangement, Fries, Claisen and cope rearrangement.	
4	**Stereochemistry:** Configurational and conformational isomerism in acyclic and cyclic compounds, Conformational analysis of cycloalkanes, decalins, Syn pentane interaction, Allylic strain (A1,2 and A1,3), anti-periplanar, syn-periplanar orientation, Chirality (centre, axial, planar & helical), Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes), Optical purity, specific rotation, enantiomeric excess (ee), diastereomeric ratio. Zimmerman–Traxler model in Aldol reaction. Conformationally allowed and forbidden reactions, Configuration and Conformation driven elimination and substitution reactions.	12
Total		**56**

Textbooks:

1. Organic Chemistry by Clayden, Greeves and Warren, Oxford Univ. Press, 2nd Ed (2012).
2. Modern Organic Reactions, H. O. House, W.A. Benjamin. 2nd Ed.(1972)
3. Principles of Organic Synthesis, R.O.C. Norman and J. M. Cox, CRC Press 3rd (2014).
4. Stereochemistry of Organic Compounds, E. L. Eliel, S. H. Wilen, L.N. Mander, John Wiley & Sons, Inc., New York, NY. (1994).
5. A Guide Book of Mechanism in Organic Chemistry, Peter Sykes, Longman.6th Ed.(1999)
6. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Part-A and B Springer, 5th Ed (2005)
7. Walsh, P. J., Kozlowski, M. C. *Fundamentals of Asymmetric Catalysis*, University Science Book, **2009**.
8. Ojima, I. *Catalysis in Asymmetric Synthesis*, Wiley-VCH, **2004**.
9. Carreira, E., Kvaermo, L. *Classics in Stereoselective Synthesis*, Wiley-VCH, **2009**.
10. Reaction Mechanism in Organic Chemistry, S. M. Mukherjee and S. P. Singh, McMillan,3rd Ed (2009)
11. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press,3rd (1957).
12. Introductory Photochemistry, A. Cox and T. Camp. McGraw-Hill.
13. Fundamentals of Photochemistry, K. K. Rohtagi-Mukherji, Wilcy-Eastern
14. Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press

Assessment and Expectations from Class: Tutorial, Quiz, Midsem-20, Endsem-80, attendance, Punctuality, doubt clearing class, Assignments.

Semester: I **Credits: 4 (core)**

Course No. **CHE-102**

Course Name: **Inorganic Chemistry-I**

Pre-requisites: B.Sc. (Hons.) Inorganic Chemistry

Objective and brief description on course and expectations: This course gives an in-depth understanding of a broad range of basics of inorganic chemistry. The student will learn regarding type of bonding nature in the molecule and metal complex. The course will give an overall understanding of bonding theory such as VBT, MOT; Π-acceptor ligands; Rings, Cages and Metal Clusters; Nuclear Chemistry.

Course Details:

Chapter/ Unit	**Contents**	Hours/ Semester
1	Valence bond Theory :Qualitative discussion on valence bond theory- formation of hydrogen molecule, Qualitative discussion on molecular orbital theory, bonding and antibonding orbitals, energy distribution and stability, VSEPR theory, shapes of simple molecules and ions, Linnet's double quartet theory and spectra of simple molecules. Hybridization and wave mechanical description for sp, sp^2 and sp^3 hybrid orbitals, qualitative idea about dsp^2,dsp^3 and d^2sp^3 hybrid orbitals, Molecular Orbital Theory: MO energy level diagrams of simple diatomic and polyatomic molecules, Walsh diagram	12
2	Metal Π-Complexes*:* Chemistry of metal carbonyls, Constitution of metal carbonyls: mononuclear, poly nuclear clusters with terminal and bridge carbon monoxide ligand units, Carbonylate anions, Carbonyl hydrides and Carbonyl halides. Metal nitrosyl and other types of metal nitric oxide complexes, Cyanonitrosyl complexes of metals, Brown ring compounds, dinitrogen complexes.	12
3	Rings, Cages and Metal Clusters*:* Inorganic catenation and hetero catenation; Synthesis, structure and reactivity of borazines, phosphazenes, borides, carbides, silicones, silicates, boron nitride; boranes, carboranes, metallaboranes and metallacarboranes, Isolobal analogs of p-block and d-block clusters; low and high nuclearity carbonyl clusters; compounds with metal-metal multiple bonds.	12
4	Nuclear Chemistry: Mass and charge, nuclear moments, binding energy, mass defect, packing fraction, stability, magic numbers. Modes of radioactive decay and rate of radioactive decay - half-life, average life, radioactive equilibrium, Energetics and types - nuclear fission- liquid drop model - nuclear fusion - essential features of nuclear reactors - tracer techniques, neutron activation analysis - carbon and rock dating - application of tracers in chemical analysis, reaction mechanisms, medicine and industry.	12
Total		**48**

Textbooks:

1. Advanced Inorganic Chemistry: F. A. Cotton, G. Wilkinson, C. A. Murillo, M. Bochmann, John Wiley and Sons Press, 3rd Ed. (1995).

2. Inorganic Chemistry-Principles of Structure and Reactivity: J. E. Huheey, E. A. Keiter, R. L. Keiter, Harper-Collins, NY, 4th Ed. (1993).
3. Inorganic Chemistry: G. L. Missler and D. A. Tarr, Prentice Hall, 3rd Ed. (2003).
4. Inorganic Chemistry: D. F. Shriver, and P. W. Atkins, Oxford University, 3rd Ed. (1999).
5. Chemistry of the Elements. N. N. Greenwood, and A. Earnshaw, Elsevier, 2nd Ed. (1997).
6. Essential of Nuclear Chemistry: H. J. Arnikar, Wiley,NY, 2nd Ed.(1987).

Assessment and Expectations from Class: Tutorial, Quiz, Midsem-20, Endsem-80, attendance, Punctuality, doubt clearing class, Assignments.

Semester: I **Credits: 4 (core)**

Course No. **CHE-103**

Course Name: **Physical Chemistry-I**

Pre-requisites: B. Sc. (Hons.) Chemistry

Objective and brief description on course and expectations: This course will provide the basic concept of the structure, behaviour of molecule and chemical phenomena at the microscopic level.

Course Details:

Chapter/ Unit	Contents	Hours/ Semester
1	**Symmetry and group theory:** Symmetry elements and Symmetry operations, Mathematical requirements for a point group, Group, Subgroup and classes, matrix representation for the E, Cn, σv, Sn, Matrix representation of point groups (C_{2v}, C_{3v} C_{4v}), Transformation matrices, Irreducible representation, Construction of character table (C_{2v}, C_{3v}, C_{4v},C_{2h}, D_2, D_{2d}), Mulliken symbolism rules for IRS, Standard reduction, Direct product.	12
2	**Application of group Theory:** Symmetry of Normal modes of Molecules: Infrared and Raman activity for C_{2v} and C_{3v}, Linear combination of atomic orbitals (LCAO) theory: In-phase and out phase interaction of atomic orbital wave function; Hybridization scheme for σ and π bonding: D_{4h}, T_d, O_h; projection operator and the ligand group orbitals, Hybrid orbital as linear combination of atomic orbitals, Molecular orbitals theory of coordination compounds: σ and π-bonding in octahedral complexes, Formation of LGOs, Formation of MOs, Construction of MO energy level diagram.	12
3	**Quantum chemistry:** Black Body radiation, photoelectric and Compton effects, atomic and molecular spectra, particle diffraction, wave-matter duality, Postulates of quantum mechanics, Operator: Linear operator and Hermitian operator, set up quantum mechanics operators (Momentum, Hamiltian and Angular momentum operator); Translational motion: Particle in one and three dimensional boxes, Tunnelling; Vibrational motion of a particle; Rotational motion: particle in a ring, sphere, Rigid rotator; Hydrogen atom and hydrogen like atoms, Shapes of *s, p* and *d*-orbitals.	12

4	**Atomic and Molecular structure:** Approximation methods: The variation method, Perturbation method (first order, second order), Application of variation methods and perturbation method to Helium atom, The ground and excited states of Helium, Born Oppenheimer approximation, Molecular Orbital theory: H_2^+, H_2, Valence Bond theory: H_2^+, H_2, Huckel theory of conjugated systems, Bond order and charge density calculation, Application to ethylene, butadiene, cyclopropenyl radical.	12
Total		**48**

Textbooks:

1. K. Veera Reddy, *Symmetry and Spectroscopy of Molecules*, New Age International, Delhi
2. Mark Ladd, Symmetry and group theory in chemistry, Horwood Publishing Chichester, England.
3. Arthur M. Lesk, Introduction to Symmetry and Group Theory for Chemists, Kluwer Academic Publishers, London.
4. Kieran C Molloy, Group Theory for Chemists: Fundamental Theory and Applications**,** Woodhead Publishing, Oxford.
5. F.A. Cotton, *Chemical Applications of Group Theory*, Wiley, India.
6. I.N. Levine, *Quantum Chemistry*, 5th edition (2000), Pearson Educ. Inc., New Delhi.
7. R.K. Prasad," *Quantum Chemistry*", New Age International, New Delhi
8. John P. Lowe & Kirk A. Peterson, Quantum Chemistry, Elsevier/Academic Press
9. Peter Atkins & Ronald Friedman, Molecular Quantum Mechanics, , Oxford Press.
10. Michael Mueller, Fundamentals of Quantum Chemistry, Kluwer Academic Publishers New York.

Assessment and Expectations from Class: Tutorial, Quiz, Midsem-20, Endsem-80, attendance, Punctuality, mock test, assignment, doubt clearing class, Assignments.

Semester: I Credits: 4 (core)

Course No. CHE-104

Course Name:Physical Spectroscopy

Pre-requisites: B. Sc. (Hons.) Chemistry

Objective and brief description on course and expectations: This course gives an in-depth understanding of a broad range of basics of molecular spectroscopy. The student will learn about microwave, vibrational, Raman, and photoelectron spectroscopy. In addition student will learn the application of EPR and Mossbauer spectroscopy.

Course Details:

Chapter /Unit	Contents	Hours/ Semester
1	**Microwave spectroscopy***:* Classification of molecules, Rigid rotator model, Effect of isotopic substitution on transition frequencies, Non- rigid rotator., Stark effect, Applications. **Atomic spectroscopy:** Electronic configuration, Russell-Saunders terms and coupling schemes, Franck-Condon principle, magnetic effects: spin-orbit coupling and Zeeman splitting,	12
2	**Vibrational Spectroscopy***:* Vibrational energy of diatomic molecules, zero point energy, force constant and bond strength, Morse potential energy diagram, vibrational-rotational spectroscopy, P,Q,R branches, break – down of Oppenheimer approximation, vibration of polyatomic molecules, Selection	12

	rules, Normal mode of vibration, Group frequencies, Overtones, Hot bands, Factors affecting the band positions and intensities for IR- region.	
3	**Raman Spectroscopy***:* Classical and quantum theories of Raman effect. Pure rotational, vibrational and vibrational-rotational Raman spectra, selection rules, Mutual exclusion principle. Resonance Raman spectroscopy, coherent anti Stokes Raman spectroscopy (CARS). **Photo electron spectroscopy***:* Basic principles, Photoelectric effect, Ionisation process, Koopmans's thermo photoelectron spectra of simple molecules, ESCA, Chemical information from ESCA, Auger electron spectroscopy.	12
4	**EPR Spectroscopy***:* Electron spin resonance spectroscopy : Basic principles , Zero- field splitting and Kramer's degeneracy, lande splitting factor g-value, Measurement techniques, Application (H, CH_3, AlH_3, Pirazine, benzyl, $(OMe)CH_2$, TEMPO, Cu(II), V(III), Ti (II), Mn(V) radicals). **Mossbauer spectroscopy***:* Basic principles, Spectral parameters and spectral display, Application of the techniques to study the bonding and structure of Fe^{2+} and Fe^{3+} compounds including those of intermediate spins.	12
Total		**48**

Textbooks:

1. Fundamental of Molecular Spectroscopy, C. N. Banwell and E. McCash, Tata McGraw Hill, 4th edition, 1994, New Delhi.
2. Spectroscopic identification of organic compounds- R.M. Silverstein and G.C. Bassler
3. Spectroscopic methods in organic chemistry- D.H. Williams and I. Fleming
4. Absorption spectroscopy of organic molecules- V.M. Parikh
5. Modern Spectroscopy, J.M.Hollas, John Wiley, 4th edition, 2004, Sussex.
6. Applied Electron Spectroscopy for Chemical Analysis Ed. H. Windawi and F. L. Ho, Wiley Inter science.
7. Physical Methods in Chemistry, R.S.Drago, Sauders College.
8. Introduction to Molecular Spectroscopy, G.M.Barrow, McGraw Hill
9. Electron Paramagnetic resonance of transition ions, A. Abraham and B. Bleaney, Clarendon Press, 1970, Oxford.
10. Introduction to magnetic resonance , A Carringtone and A D McLachalan, Harper & Row
11. Introduction to Photoelectron Spectroscopy, P.K.Ghosh, John Wiley
12. Molecular Spectrocopy, P.S. Sindhu, Tata McGraw Hill , 1985, New Delhi.
13. Symmetry ans Spectroscopy of Molecules, , K.V. Reddy, New Age International (P) Ltd., Ist edition, 1998, New Delhi

Assessment and Expectations from Class: Tutorial, Quiz, Midsem-20, Endsem-80, attendance, Punctuality, doubt clearing class, Assignments.

Semester: I **Credits: 4 (core)**

Course No. **CHE-105**
Course Name: **Organic Practical**

Pre-requisites: B. Sc. (Hons.) Chemistry

Objective and brief description on course and expectations : This is a basic organic chemistry practical course. In this laboratory course, students would be able to use their knowledge of chemical reactivity to plan and execute the preparation of compounds using various C-C and C-hetero bond-forming reactions and various organic transformations from commercially available starting materials. Upon completion of this laboratory course, the students would also get confidence on working independently and characterize the synthesized compounds using various modern techniques.

Course Details:

Chapter/ Unit	Contents	Hours/ Semester
1	**Rf determination & Mixture separation by TLC:** 1. Preparation of TLC stains and their application in chromatographic technique. 2. Determination of Rf Value of binary and ternary mixtures and number of component by TLC 3. Separation of organic mixtures (binary/ternary) by column chromatography	24
2	**Oxidation-reduction & nitration method:** 4. Preparation of amide: Synthesis of p-nitroacetanilide from acetanilide. 5. Reduction of ketone: Preparation of benzhydrol from benzophenone using $NaBH_4$ 6. Oxidation of olefin with $KMnO_4$: Preparation of adipic acid from cyclohexene 7. Preparation of pyridinium chlorochromate (PCC) and its use for the oxidation of an suitable alcohol	24
3	8. **Aldol reaction**: Preparation of dibenzylideneacetone 9. **Etherification** of alcohol: Preparation of 2-ethoxynaphthalene 10. **Hydrolysis of ester**: Preparation of salicylic acid from methyl salicylate 11. Preparation of: ethylbenzoate/ Anthranilic acid/Methyl Orange/azo-dye. 12. **Beckmann rearrangement**: Preparation of benzanilide from benzophenone oxime.	24
4	Systematic identification of organic compounds from mixture.	24
Total		**96**

Textbooks :

1) Quantitative and Qualitative analysis By A.I. Vogel
2) Experiments and Techniques in Organic Chemistry, D.Pasto, C. Johnson, & M.Miller, Prantice Hall.
3) Systematic Qualitative Organic Analysis, H. Middleton, Edward Arnold (Publisher).
4) Hand Book of Organic Analysis, Qualitative & Quantitative, M.T. Clarke, Edward Arnold (Publisher).
5) Vogel's Text Book of Practical Organic Chemistry, A.R. Tatchell, John Wiley.

6) Macroscale and Microscale Organic Experiments, K. L. Williamson, D. C. Heath.
7) A Text Book of Practical Organic Chemistry (Qualitative). Arthur I. Vogel.

Assessment and Expectations from Class: Tutorial, Quiz, Endsem-100, attendance, Punctuality, doubt clearing class.

SEMESTER-II

Semester: II Credit: 4 (core) Course No. CHE-206
Course Name: Organic Chemistry-II

Pre-requisites: (101)

Objective and brief description on course and expectations: This course gives an in-depth understanding of a broad range of organic reactions from oxidation-reduction mechanism perspectives to use of organomettallics, pericyclic. It gives an understanding how the chemical transformations achievable through interaction between light/heat and organic compounds.

Course Details:

Chapter/ Unit	Contents	Hours/ Semester
1	**Oxidation:** Different oxidative processes, oxidation of alkene, aromatic ring, alcohol , α, β-diol, allylic and benzylic alcohols, aldehydes, amines (*N*-Oxidation). epoxidation (m-CPBA, Sharpless, Jacobsen), Swern Oxidation, Alkene oxidation by Ozonolysis, Hydroboration-Oxidation, Oxymercuration-demecruration and Sharpless Dihydroxylation, Wacker Oxidation. Oxidation with RuO_4, Idobenzene diacetate (BAIB)-TEMPO, PCC, PDC, Jones oxidation, IBX, Dess-Martin-Periodinane (DMP), SeO_2, CrO_3, TPAP, MnO_2. Sulfonium ylide oxidation. Chemo- and Stereoselctive Oxidation.	14
2	**Reduction***:* Different reductive processes, Reduction of alkenes, alkynes, aromatic rings, cycloalkenes, carbonyl compounds, aldehydes, ketones, acids and their derivatives. Catalytic reductions: hydrogenation, hydrogenolysis, Rosenmund reduction, Lindlar reduction, Adam's reduction, Wilkinson reduction, Raney Nickel. Hydride reduction: $NaBH_4$, Luche reduction, $NaCNBH_3$, B_2H_6, $LiAlH_4$, $LiEt_3BH$, DIBAL, L-selectride, K-selectride. Birch Reduction and dissolved metal reduction, Wolf-Kishner Reduction, Clemmensen reduction, diimide reduction. Asymmetric reduction: CBS reduction, Noyori Reduction, Baker-Yeast Reduction. Chemo- and Stereoselective and Stereospecific Reduction.	14
3	**Applications of Organometallics***:* Synthetic applications of organozinc, organocadmium, organolithium, organomercury and organocopper compounds. Gilman-Corey reagent. Oxidative addition and reductive elimination, Coupling reactions (Heck, Stille, Negishi, Kumada, Suzuki, Sonogashira, Hartigw-Buchwald, Miyaura and Pauson-khand). Synthesis and Applications of organ magnesium compmounds.	10
4	**Pericyclic Reactions***:* Conservation of orbital symmetry, Woodward-Hoffmann rules, frontier molecular orbital (FMO) theory, Correlation approach for Orbital overlap effects in cycloadditions, electrocyclizations, sigmatropic rearrangements	12

	and Chelotropic reactions, Claisen Rearrangement, Cope rearrangement, Ene reaction.	
Total		**50**

Textbooks:

1. Organic Chemistry by Clayden, Greeves and Warren, Oxford Univ. Press, 2nd Ed (2012).
2. Modern Organic Reactions, H. O. House, W.A. Benjamin. 2nd Ed.(1972)
3. Principles of Organic Synthesis, R.O.C. Norman and J. M. Cox, CRC Press 3rd (2014).
4. Isaacs, N. S. *Physical Organic Chemistry*, Prentice Hall, 1996.
5. Deslongchamps, P. *Stereolectronic Effects in Organic Chemistry*, Elsevier Science, 1983.
6. Carey, F. A., Sundberg, R. J. *Advanced Organic Chemistry*, *Part A and B*, Springer, 2007.
7. Turro, N. J. *Modern Molecular Photochemistry*, University Science Books, 1991.
8. Anslyn, E. V., Dougherty, D. A. *Modern Physical Organic Chemistry*, University Science Books, 2005.
9. Woodward, R. B., Hoffmann, R. *The Conservation of Orbital Symmetry*, Verlag Chemie, 1970.
10. Lehr, R. E., Marchand, A. P. *Orbital Symmetry: A Problem Solving Approach*, Academic Press, 1972.
11. Pericyclic Reactions, S. M. Mukherji, Macmillan, India.
12. Name reactions and Reagents in Organic Synthesis 2nd Ed, Bradford P Munday, Michael G. Ellerd and Frank G. Favaloro, Jr. Wiley Interscience

Assessment and Expectations from Class: Tutorial, Quiz, Midsem-20, Endsem-80, attendance, Punctuality, doubt clearing class, Assignments.

Semester: II Credits: 4 (core)

Course No. CHE-207
Course Name: Inorganic Chemistry-II

Pre-requisites (102)

Objective and brief description on course and expectations : The student will learn regarding Bonding in Co-ordination Compounds; Spectral and Magnetic Properties of Transition Metal Complexes, Metal-Ligand Equilibria in Solution; Reaction Mechanism of Transition Metal Complexes

Course Details:

Chapter/ Unit	Contents	Hours/ Semester
1	**Bonding in Co-ordination Compounds:** Valence bond theory-strength and short comings, Crystal field theory-effect spin types, CFSE, Evidence for crystal stabilization energy in octahedral, tetrahedral, tetragonal, square pyramidal and square planner fields, Applications of Crystal Field Splitting, Jahn-Teller Theorem, Molecular orbital theory (qualitative), MO energy level diagrams, Sigma–pi bonding and their importance in co-ordination compounds	12
2	**Spectral and Magnetic Properties of Transition Metal Complexes:** Spectroscopic ground states, Correlation and Orgel diagrams for transition metal complexes (d1-d9 states), Tanabe-Sugano *diagrams,* Charge transfer spectra, Elementary idea about magneto chemistry of metal complexes,	12

	Diamagnetism, Para magnetism, Temperature independent paramagnetism, Magnetic susceptibility and its measurement, Paramagnetism applied to metal complexes, Ferromagnetism, Ferrimagnetism and Anti-ferromagnetism.	
3	**Metal-Ligand Equilibria in Solution;** Stepwise and overall formation constants, Trends in stepwise constants, Inert and labile complexes, Kinetic application of 13 valence bond and crystal field theories, Kinetics of octahedral substitution, Factors affecting stability of metal complexes with reference to the nature of metal ion and ligand, Chelate effect and its thermodynamic origin, Determination of binary formation constants by potentiometric and spectrophotometric methods.	12
4	**Reaction Mechanism of Transition Metal Complexes:** Acid hydrolysis, Factors affecting acid hydrolysis, Base hydrolysis, Conjugate base mechanism, Direct and indirect evidences in favour of conjugate mechanism, Anation reactions, Reactions without metal ligand bond cleavage, Substitution reactions in square planar complexes, Trans effect, Mechanism of one electron reactions, Outer-sphere type reactions, Marcus-Hush theory, Inner sphere type reactions.	12
Total		**48**

Textbooks :

1. Advanced Inorganic Chemistry: F. A. Cotton, G. Wilkinson, C. A. Murillo, M. Bochmann, John Wiley and Sons Press, 3rd Ed. (1995).
2. Inorganic Chemistry-Principles of Structure and Reactivity: J. E. Huheey, E. A. Keiter, R. L. Keiter, Harper-Collins, NY, 4th Ed. (1993).
3. Inorganic Chemistry: G. L. Missler and D. A. Tarr, Prentice Hall, 3rd Ed. (2003).
4. *Inorganic Chemistry:* D. F. Shriver, and P. W. Atkins, Oxford University, Oxford, 3rd Ed. (1999).
5. Mechanisms of Inorganic Reactions: F. Basolo and R. G. Pearson, John Wiley & Sons, 2nd Ed. (1967).
6. Inorganic Electronic Spectroscopy: A. B. P. Lever, Elsevier, 2nd Ed. (1984).
7. Magneto-chemistry: R. L. Carlin, Springer-Verlag, (1986).
8. Elements of Magnetochemistry, R. L. Dutta, A. Syamal, Affiliated East-West Press, 2nd Ed. (2004).

Assessment and Expectations from Class: Tutorial, Quiz, Midsem-20, Endsem-80, attendance, Punctuality, doubt clearing class, Assignments.

Semester: II **Credits: 4 (core)**

Course No. CHE-208
Course Name: Physical Chemistry-II

Pre-requisites (103)

Objective and brief description on course and expectations: This course will provide the knowledge of thermodynamics and its relation to microscopic physical laws. The last part of this course gives the understanding of mechanism of chemical processes.

Course Details:

Chapter/ Unit	Contents	Hours/ Semester
1	**Classical thermodynamics:** Brief resume of the concept of internal energy, enthalpy, entropy, free energy, Adiabatic and isothermal processes; laws of thermodynamics: first law, second law, third law; Effect of temperature and pressure on thermodynamics quantities: free energy, entropy, equilibrium constant, The principle of le Chatelier, Partial molar properties, Chemical potential, Determination of partial molar properties by: (1) Direct Method, (ii) Method of intercept; Phase equilibria: Conditions for equilibrium between phases, The phase rule, Systems of one component-water, Thermodynamics of non ideal solution: Concept of fugacity and its determination by (i) Graphical method, (ii) From equation of state (iii) Approximation method.	12
2	**Statistical thermodynamics:** Thermodynamic probability and entropy, Maxwell-Boltzmann statistics, Partition function (translational, vibrational, rotational and electronic) for diatomic molecules, relationship between partition and thermodynamic function (internal energy, enthalpy, entropy and free energy), Calculation of equilibrium constant, Fermi-Dirac statistics, Bose-Einstein statistics, Distribution law and its application to metal.	12
3	**Non-equilibrium thermodynamics:** Thermodynamic criteria for non-equilibrium states, Entropy production: heat flow and chemical reaction; Transformation of the generalized fluxes and forces, Non-equilibrium stationary state, Microscopic reversibility, Onsager's reciprocity relation, Electrokinetic phenomena, Diffusion, Electric conduction.	12
4	**Chemical Dynamics:** Collision theory of reaction rate, Activated complex theory, Arrhenius equation, Ionic reaction, Kinetic salt effect, Steady state kinetics, Photochemical reaction (Hydrogen-Bromine and Hydrogen-Chlorine reactions), Oscillatory reactions (Belousov-Zhabotinsky reaction), Homogeneous catalysis, General features of fast reaction, Study of fast reaction by flow method and relaxation method. Dynamics of Unimolecular reactions (Lindemann-Hinshelwood and Rice-Ramsperger-Kassel-Marcus theories)	12
Total		**48**

Textbooks :

1. Walter J. Moore, Physical Chemistry , Orient Longman, London 1972.
2. Thermodynamics, Gurdeep Raj, Goel Publishing House, Meerut.India
3. P. W. Atkins, Physical Chemistry, Seventh Edition (2002), Oxford University Press, NewYork.

4. I.N. Levine, Physical Chemistry, 5th Edition (2002), Tata McGraw Hill Pub. Co. Ltd., New Delhi.
5. Andrew Maczek, Statistical Thermodynamics, (1998) Oxford University Press Inc., New York
6. K. J. Laidler, Chemical Kinetics, Third Edition (1987), Harper & Row, New York
7. Paul L. Houston, Chemical Kinetics and Reaction Dynamics, Dover Publications, New York.
8. J. Raja Ram and J.C. Kuriacose, Kinetics and Mechanism of Chemical Transformations (1993), MacMillan Indian Ltd., New Delhi.
9. PK. Nag. Basic and applied thermodynamics, Tata McGraw Hill Pub. Co. Ltd., New Delhi.
10. S.R. DeGroot and P. Mazur, Non-equilibrium thermodynamics, Dover Publications, Inc. NewYork
11. Donald A. McQuarrie and John D. Simon, Physical Chemistry A Molecular Approach, USA.
12. Thomas Engel and Philip Reid, Physical Chemistry, Pearson, New York.
13. Andrew Cooksy, Physical Chemistry, Thermodynamics, Statistical Mechanics, & Kinetics, Pearson, New York.

Assessment and Expectations from Class: Tutorial, Quiz, Midsem-20, Endsem-80, attendance, Punctuality, mock test, assignment, doubt clearing class, Assignments.

Semester: II **Credits: 4 (core)**

Course No. CHE-209
Course Name: Organic Spectroscopy

Pre-requisites (101, 201)

Objective and brief description on course and expectations : The student will learn how to identify an organic molecule through organic spectroscopy. The student should be able to know application of spectroscopy for unknown compound identification by Combined UV, IR, Mass and NMR spectroscopy.

Course Details

Chapter/ Unit	Contents	Hours/ Semester
1	**UV spectroscopy**: Various electronic transitions (185–800 nm), Jablonski diagram, Beer–Lambert Law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Woodward-Fieser rules (for conjugated dienes and carbonyl compounds) & Fieser-Kuhn rule (for polyenes), ultraviolet spectra of aromatic and heterocyclic compounds. Effect of Inductive, Resonance and Hyper conjugation effect on λ_{max}. **IR spectroscopy**: Theory & principle of IR spectroscopy, Modes of stretching and bending, Fourier Transform Spectrometers, Background spectrum, Survey of important functional groups with examples, Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance, FTIR.	12

2	**Nuclear Magnetic Resonance***:* Physical basis of Nuclear Magnetic Resonance spectroscopy, Basic principle, Shielding mechanism, Chemical shift and Spin-spin coupling as functions of structure, Karplus curve variation of coupling constant with dihedral angle. Analysis of high-resolution NMR spectra, FT and pulse-NMR, 19F and 31P NMR, Nuclear Overhauser effect (NOE). **Carbon-13 NMR Spectroscopy:** General considerations, chemical shift, coupling constants. Spin-spin, spin-lattice relaxations. Off resonance decoupling. DEPT. Interpretation of simple CMR spectra. 2D NMR: (COSY, INADEQUATE, DEPT, HMQC, HSQC, HMBC, NOESY)	15
3	**Mass spectroscopy***:* Principles of Mass Spectrometry, Molecular ion peak, Metastable ions, McLafferty rearrangement, Nitrogen rule. Ion sources (EI, CI, Field Ionization, FAB, Plasma desorption, Field desorption, Laser desorption, MALDI, Thermospray, API, ESI, APCI, APPI, Atmospheric pressure secondary ion mass spectrometry, inorganic ionization techniques, formation and fragmentation of ions, fragmentation reactions, Mass analyzers (Quadrople, Ion trap, ToF, Orbitrap, magnetic and electromagnetic analyzers), Ion cyclotron resonance and FT-MS.	12
4	**Structure elucidation**: Application of IR, UV-Vis, ^{1}H , ^{13}C, Mass spectroscopic techniques for structure determination of organic compounds with exhaustive examples	9
Total		**48**

Textbooks :

1. Donald L. Pavia, Gary M. Lampman, George S. Kriz, James A. Vyvyan: *Introduction to Spectroscopy*, 4th Edition, Brookes Cole, 2008.
2. Harald Gunther: *NMR spectroscopy, Basic principles, concepts, and applications in chemistry*, 2nd Ed., Wiley, 2001 (reprint)
3. Timothy Claridge: *High Resolution NMR Techniques in Organic Chemistry*, 2nd Ed. Elsevier, 2009
1. 16
4. Edmond de Hoffmann, Vincent Stroobant: *Mass Spectrometry, Principles and applications*, 3rd Edition, Wiley, 2007
5. Robert M. Silverstein, Francis X. Webster, David Kiemle: *Spectrometric identification of organic compounds*, 7th Edition, Wiley, 2005.
6. Organic Chemistry by Clayden, Greeves and Warren, Oxford Univ. Press, 2nd Ed (2012).

Assessment and Expectations from Class: Tutorial, Quiz, Midsem-20, Endsem-80, attendance, Punctuality, doubt clearing class, Assignments.

Semester: II **Credits: 4 (core)**

Course No. CHE-210
Course Name: Inorganic Practical

Pre-requisites: B. Sc. (Hons.) Inorganic Chemistry Practical & (412, 422)

Objective and brief description on course and expectations: The student will learn the practical knowledge for Qualitative analysis of mixtures containing not less than six radicals, volumetric estimation of metal including magnetic state determination and preparation of inorganic metal complexes.

Course Details:

Chapter/ Unit	Contents	Hours/ Semester
1	Qualitative analysis of mixtures containing not less than six radicals (organic radicals should be excluded). Anyone of the following rare metal ions may be included. **(V, Mo, W, Ti).**	24
2	**A) Volumetric analysis involving EDTA as reagent.** i) Determination of Ca_2^+ and Mg_2^+ in Dolomite. ii) Determination of Nickel in Stainless steel.	24
3	**B) Complete analysis of:** i) Brass ii) Cement iii) chromo iron ore.	24
4	**C) Preparation of Hexamine Cobalt (III) chloride.** D) Gouy's method for Determination of magnetic susceptibility of coordination complex.	24
Total		**96**

Textbooks:

1. Vogel's Textbook of Quantitative Chemical Analysis, A. I. Vogel, Longman, 5th Ed. (1989).
2. Vogel's Qualitative Inorganic Analysis, A. I. Vogel, Pearson Education India, 7th Ed. (2012).

Assessment and Expectations from Class: Endsem-100, attendance, Punctuality, doubt clearing class.

SEMESTER-III

Semester: III **Credits: 4 (core)**

Course No. CHE-311
Course Name: Analytical Chemistry

Pre-requisites: B. Sc. Chemistry (Hons.)

Course Details:

Chapter/ Unit	Contents	Hours/ Semester
1	**Thermal methods of analysis:** Thermo analytical methods: TGA, DTGA and DTA, Instrument, Instrumental and application to physical studies (reaction kinetics and information for the constitution of phase diagram), Analytical applications, Separation of Ca, Sr, and Ba comparison of purity.	12
2	**Electrical methods of analysis:** Voltametry and polarography: Dropping mercury electrode, Ilkovic equation, Current-potential curves, Reversible reactions, The residual current, Current maxima, Analytical applications, Amperometric titration using rotating platinum electrode, Cyclic voltammetry.	12
3	**Atomic absoption spectroscopy:** Atomic Absorption spectroscopy-Principle, difference between atomic absorption spectrophotometry and flame emission spectroscopy, Advantages of Atomic Absorption spectroscopy, Instrumentation, Detection limit and sensitivity. Flame photometry, principle, Instrumentation interference in flame photometry, Application.	12
4	**Chromatography:** Definition and classification of chromatography, Chromatography terminology. Theory of chromatographic migration, thin layer chromatography, Principle and preparation of TLC plate, choice of adsorbent and solvent system, experimental techniques and application of TLC. Ion exchange mechanism of ion exchange, technique of ion exchange and application of ion exchange for separations, Gel permeation chromatography, Electrophoresis, its apparatus and methodology	12
Total		**48**

Text books:

1. Instrumental methods of chemical analysis, Gurdeep R. Chatwal and Sham K. Anand, Himalaya Publishing House, New Delhi.
2. Instrumental Methods of Analysis, . H.HWillard, L.L. Merritt , J.A. Dean and F.A. Settle, CBS publishers, new Delhi.
3. Chromatography: Fundamentals and applications of chromatography and related, E. Heftmann, Elsavier, Ansterdam.
4. Atomic Absorption Spectrometry, Bernhard Welz, Michael Sperling, Wiley, New York.
5. Analytical Chemistry**,** Dash, Dhruba Charan, PHI learning Private limited, New Delhi.

Assessment and Expectations from Class: Tutorial, Quiz, Midsem-20, Endsem-80, attendance, Punctuality, doubt clearing class, Assignments

Semester: III **Credits: 4 (core)**

Course No. CHE-312
Course Name: Organic Synthesis

Pre-requisites (101, 206)

Objective and brief description on course and expectations: The student will learn about disconnection approach and retrosynthesis, synthesis of heterocycles, natural Product synthesis and use of synthetic reagents in organic synthesis, Organic Polymers. The student can independently plan to synthesize a target molecules.

Course Details:

Chapter/ Unit	Contents	Hours/ Semester
1	**Disconnection approach and Retrosynthesis:** Synthons and synthetic equivalents, disconnection approach, functional group interconversions. One group C-X and two group disconnections in 1,2-, 1,3-, 1,4- & 1,5-bifunctional compounds, Chemoselectivity, reversal of polarity- Umpolong, cyclization reaction, amine synthesis. Michael addition, Diels-Alder reaction and Robinson annulation. **Protecting Groups:** Principle of protection of alcohol, diol, amine, carbonyl, carboxyl groups and their deprotection.	12
2	**Heterocycles***:* Saturated heterocycles, synthesis of 3-, 4-, 5- and 6-membered rings (1 or 2 hetero atom), aromatic heterocycles in organic synthesis. Paal-knorr synthesis of pyrrole, furan & thiophene. **Natural Product Synthesis:** Saccharin Synthesis. Synthesis of Salbutamol, L-DOPA, prostaglandin $F_2\alpha$, Aspirin, α-pinene, Longifolene, Artimisnin, Imatiniv, Quinine, Remdesivir. Favipiravir.	12
3	**Synthetic Reagents:** Complex metal hydrides, DIBAL, L-selectride, K-selectride, Superhydride, Me_2CuLi, LDA, n-BuLi, t-BuLi, DIPEA (Hunig's base), NaH, DCC, Yamaguchhi esterification, Me_3SiI, Peracids-m-CPBA, Dioxirane, Criegee reagent {$Pb(OAc)_4$}, PPA, CH_2N_2, NBS, Bu_3SnH-AIBN, OsO_4, ADmix-α, ADmix-β, CBS catalyst, Wittig Ylide, Sulfur Ylide, Corey-Fuch, Ohira-Bestmann, Simon-Smith (CH_2I_2-Zn/Cu), Kulin-Kuvich clopropanation, Peterson Olefination, Petasis reagent (Petasis olefination), Horner Wittig, Grubbs catalyst, Phase Transfer Catalyst (PTC).	15
4	**Organic Polymers:** Basic concepts of Polymer, Classification, Number, weight and viscosity average molecular weights. Polydispersity and molecular weight distribution. Mechanism of polymerization (Cationic/anionic/Free radical). Synthesis and application of Polyamide, Polyester, Poly carbonate, Living Polymer, Bio-degradable polymer, Zeigler-Natta polymerization, Atactic, Syndiotactic and isotactic Polymer, Solid state peptide synthesis.	9
Total		48

Textbooks :

1) Organic synthesis: Clayden, Greeves & Warren Oxford Univ. Press, 2nd Ed (2012).
2) Heterocyclic Chemistry by J. A. Joule and K. Mills, Wiley, 5th Edition, 2010
3) Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Part A and B Springer, 5th Ed.(2005)

4) A Guide Book of Mechanism in Organic Chemistry, Peter Sykes, Longman.6th Ed.(1999)
5) Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press,3rd (1957).
6) Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall, 6th Ed.(1992)
7) Designing Organic Synthesis, A programmed introduction to synthon approach, S. Warren, Wiley.
8) Organic Synthesis-Concept, Methods and Starting Materials, J. Fuhrhop and G. Penzillin, VCH, Weinheim, Germany.
9) Some Modern Methods of Organic synthesis. W. Carruthers, Cambridge Univ. Press.
10) Modern Synthetic Reactions, H. O. House, W.A. Benjamin
11) Advanced Organic Chemistry: Reactions, Mechanisms and Streucture, J. March, Wiley.
12) Principles of Organic synthesis, R. Norman and J. M. Coxon, Blackie Academic & Professional.
13) Advanced Organic Chemistry Part B, F. A. Carey and R. J. Sundberg, Plenum Press.
14) Organic Chemistry: The disconnection approach, S. Warren, John Wiley and Sons
15) Name reactions and Reagents in Organic Synthesis 2nd Ed, Bradford P Munday, Michael G. Ellerd and Frank G. Favaloro, Jr. Wiley Interscience

Assessment and Expectations from Class: Assessment and Expectations from Class: Tutorial, Quiz, Midsem-20, Endsem-80, attendance, Punctuality, doubt clearing class, Assignments

Semester: III **Credits: 4**

(Core)Course No. CHE-313
Course Name: Organometallic Chemistry

Pre-requisites 102, 207

Objective and brief description on course and expectations: The student will learn about Main Group Organometallics; Transition Metal Organometallics and Applications of Organometallics to Organic Synthesis and Catalysis.

Course Details

Chapter/ Unit	Contents	Hours/ Semester
1	**Main Group Organometallics**; Synthesis and reactions of organolithium compounds; Synthesis and reactions of organomagnesium compounds; Organometallics of zinc and mercury: preparation, structure, bonding and reactions of aluminum organyls; Thallium(I) organyls (synthesis of TlCp); Organyls of sodium, synthesis of NaCp; Silicon and tin organyls of coordination number 4.	12
2	**Transition Metal–Carbon σ-Bond:** Brief review of metal alkyl compounds; transition metal carbene and carbyne complexes; transition metal vinylidene and transition metal allenylidene complexes. *(b) Transition Metal-Carbon π-Bond*: Cyclopropenyl cation ($C_3R_3^+$) as a ligand; C_4R_4 as a ligand (R = H, Me, Ph), cyclopentadienyls as ligand	12

3	**Transition Metal-Carbon π-Bond:** (a) Alkene complexes: Synthesis; Bonding; Reactivity. (b) Alkyne complexes: Synthesis; Bonding; Reactivity. (c) Cyclopropenyl cation ($C_3R_3^+$) as a ligand; C_4R_4 as a ligand (R = H, Me, Ph). (d) *Syntheses of Cyclopentadienyl and Arene Metal Analogues;* Synthesis and reactions of cyclopentadienyl metal carbonyls, cyclopentadienyl metal hydrides, cyclopentadienyl metal halides, arene metal carbonyls, η^6-arene-chromium tricarbonyl in organic synthesis.	12
4	**Applications to Organic Synthesis and Catalysis;** Stiochiometric reactions for Organometallic catalysts: Dissociation & Substitution, Oxidative addition & carbonylation, Oxygen transfer from Peroxo and Oxo Species, Reductive & Hydride elimination, Insertion, Displacement and Isomerization reaction, Hydrogenation, Hydrosilation and Hydrocynation of unsaturated compounds, Hydroformylation, Wacker (Smidt) Process, Olefin Metathesis, Fischer-Tropsch synthesis, Zeigler-Natta polymerization, Water gas reaction	12
Total		**48**

Textbooks :

1. Inorganic Chemistry-Principles of Structure and Reactivity: J. E. Huheey, E. A. Keiter, R. L. Keiter, Harper-Collins, NY, 4th Ed. (1993).
2. Organometallic Chemistry: A Unified Approach R. C. Mehrotra & A. Singh, New Age International, 2nd Ed. (2000).
3. The Organometallic Chemistry of the Transition Metals: R. H. Crabtree, John Wiley 3rd Ed. (2001).
4. Basic Organometallic Chemistry: Concepts, Synthesis and Applications B. D. Gupta & A. J. Elias, Springer Science, 2nd Ed. (2013).
5. Organometallics 1, M. Bochmann, Oxford University Press, New York (1994).
6. Organometallics 2, M. Bochmann, Oxford University Press, New York (1994).

Assessment and Expectations from Class: Assessment and Expectations from Class: Tutorial, Quiz, Midsem-20, Endsem-80, attendance, Punctuality, doubt clearing class, Assignments

Semester: III **Credits: 4 (Core)**

Course No. CHE-314
Course Name: Environmental Chemistry

Pre-requisites, if any: B. Sc. with Chemistry as subject

Course Details:

Chapter/ Unit	Contents	Hours/ Semester
1	**Environmental Processes** Environment and its classification, Environmental Impact Assessment and management, Factors influencing environment, Components of Environment; Environmental degradation, Biogeochemical cycles; Hydrological cycle, Gaseous cycles (Oxygen cycle, CO_2 cycle, Nitrogen cycle), Sedimentary cycles (Sulfur cycle, Phosphorous cycle)	12
2	**Natural Resources** Introduction, classification of resources; land resources , formation of soil, soil erosion, Water resources, Sources of fresh water, Uses of water, causes for the depletion of water resources ;mineral resources, Forest resources,	12

	Deforestation, consequences of deforestation; affords to control deforestation, Renewable and nonrenewable resources, Conventional and nonconventional energy resources	
3	**Environmental pollution** Introduction, Pollutants, Types of pollutants, Classification of pollution, effects of pollution, Radiation pollution: sources, effect and control of radiation pollution, Thermal pollution: sources, effects and its control, Industrial pollution, Sewage and sewage treatment	12
4	**Air Pollution and its control** Atmosphere; structure and composition of atmosphere, Classification of air pollutants, Consequences of air pollution (Ozone layer depletion, Greenhouse effect, Global climate, Smog, Acid rain) , Control of air pollution, air quality and standards.	12
Total		**48**

Text books:

1. Environment and Ecology By Dr. Sunakar Panda
2. Environmental Chemistry By A.K. De
3. Air Pollution By Wark & Werner
4. Environmental Pollution Control in Process Industries By S.P. Mahajan
5. Environmental Chemistry By B.K. Sharma & H.Kaur
6. Introduction to Air Pollution By P.K. Trivedi
7. Environmental Pollution Analysis By S.M. Khopkar
8. A Text Book of Environmental Pollution By D.D. Tyagi, M. Mehre
9. Environmental Pollution Engineering and Control By C.S. Rao

Assessment and Expectations from Class: Tutorial, Quiz, Midsem-20, Endsem-80, attendance, Punctuality, doubt clearing class, Assignments

Semester: III **Credits: 4**

(Core)Course No. CHE-315

Course Name: Physical & Analytical Practical

Pre-requisites, if any: 103, 208

Objective and brief description on course and expectations : The student will learn practical knowledge of physical and analytical chemistry. (Cunductometry, pHmetry, Surface tension and solubility product etc.)

Course Details:

Chapter/ Unit	Contents	Hours/ Semester
1	i) Study of kinetics of dissolution of magnesium metal in dil HCl and show that the reaction in second order. ii) Determine the rate constant of hydrolysis of methyl Acetate catalysed by HCl at room temperature, iii) Study of the adsorption of aquous acetic acid by activated charcoal and determine the Freundlish Adsorption isotherm.	

2	Determination of critical solution temperature (CST) and study of phase diagram of three-component liquid (ternary) system at room temperature.Determination of activation energy from the Kinetic measurement of hydrolysis of ester and determination of rate constant of inversion of sucrose by polarimeter and also verification of the effect of catalyst on the rate constant.	
3	Determination of dissociation constant of acid and determination of hydrolytic constant (Kh) pH-metrically. Determination of iron content in the given ferrous ammonium sulphate solution by Colorimetry and determination the composition and stability constant of Fe(III) salicylic acid complex colorimetrically by Job's method of continuous variation. Determination of Λo and Ka of weak electrolyte at a definite temperature by Debye Huckel Onsagar equation, determine the stoichoimetric ratio in the complexometric titration of HgCl2 against potassium iodide conductometrically and Determine the strength of HCL and acetic acid (AcOH) from the mixture of acids by strong alkali (NaOH) conductometrically.	
Total		**96**

Text books:

1. Experimental Physical Chemistry by R.C. Das and B. Behera
2. Text book of Quantitative Inorganic Analysis by A.I. Vogel, ELBS(1978)
3. Experimental Physical chemistry by J B Yadav, Goel Pub. House,(1981)
4. Senior Practical Physical Chemistry by B. C. Kosla, Simla Printers New Delhi (1987).
5. Experimental Physical Chemistry by Daniel et al., McGraw Hill, New York (1962).

Assessment and Expectations from Class: Tutorial, Quiz, Endsem-100, attendance, Punctuality, doubt clearing class.

SEMESTER-IV

Semester: IV **Credits: 4 (Core)**

Course No. CHE-416
Course Name: Organic Chemistry-III

Pre-requisites:

Objective and brief description on course and expectations: This course gives an in-depth understanding of a broad range of organic reactions from physical organic chemistry perspective. The topics include thermodynamic & kinetic control of organic reactions, Curtin-Hammett Principle, probing the reaction mechanisms by kinetic isotope effects, stereoelectronic effects in conformations, allylic strain and various selected reactions. Also, a detailed study and application of the theories/rules governing various cyclic reactions will be carried. A study of asymmetric synthesis is illustrated to achieve enantiopure compounds.

Course Details:

Chapter/ Unit	Contents	Hours/ Semester
1	**Chemical Equilibria and Chemical Reactivity:** Thermodynamic and kinetic control of reactions; Correlation of reactivity with structure, linear free energy relationships, Hammond's postulate, Curtin-Hammett principle, substituent constants and reaction constants **Chemical Kinetics and Isotope Effects**: Various types of catalysis and isotope effects, importance in the elucidation of organic reaction mechanisms	12
2	**Stereoelectronic Effects in Organic Chemistry:** Role of stereoelectronic effects in the reactivity of acetals, esters, amides and related functional groups; Reactions at sp3, sp2, and sp carbons, Cram, Felkin-Ahn, Zimmerman-Traxler, Houk, Cieplak, exterior frontier orbital extension (EFOE) and cation-complexation models as applied to p-facial stereoselectivity.	12
3	**Molecular strains:** Strain thermodynamics, various kinds of strains, ring strains, torsional strain, Allylic strain (A1,2 and A1,3) and other strains, Taft equation. Baldwin's rule of cyclization. Concept of aromatic, non-aromatic and anti-aromaticity.	8
4	**Asymmetric synthesis:** Chiral auxiliaries, methods of asymmetric induction – substrate, reagent and catalyst controlled reaction. Determination of enantiomeric and diastereomeric excess. Sharpless epoxidation, Jacobsen epoxidation, Sharpless Dihydroxylation using ADmix-α and ADmix-β, CBS reduction, Noyori reduction, Baker's yeast Reduction. Kinetic Resolution, Dynamic Resolution, non-linear Effect in asymmetric Synthesis, Introduction to Organocatalysis.	16
Total		**48**

Textbooks :

1. Isaacs, N. S. *Physical Organic Chemistry*, Prentice Hall, 1996.
2. Deslongchamps, P. *Stereolectronic Effects in Organic Chemistry*, Elsevier Science, 1983.
3. Carey, F. A., Sundberg, R. J. *Advanced Organic Chemistry*, *Part A and B*, Springer, 2007.
4. Turro, N. J. *Modern Molecular Photochemistry*, University Science Books, 1991.

5. Anslyn, E. V., Dougherty, D. A. *Modern Physical Organic Chemistry*, University Science Books, 2005.
6. Woodward, R. B., Hoffmann, R. *The Conservation of Orbital Symmetry*, Verlag Chemie, 1970.
7. Lehr, R. E., Marchand, A. P. *Orbital Symmetry: A Problem Solving Approach*, Academic Press, 1972.

Assessment and Expectations from Class: Tutorial, Quiz, Midsem-20, Endsem-80, attendance, Punctuality, doubt clearing class, Assignments

Semester: IV **Credits: 4 (Core)**

Course No. CHE-417
Course Name: Physical Chemistry-III

Pre-requisites: 103, 208

Course Details:

Chapter/ Unit	Contents	Hours/ Semester
1	**Electrochemistry-I:** Electrochemistry of solution: Ion-solvent interactions, Born Model, Ion-ion interactions, Debye-Huckel (ion-cloud), Bjerrum Model, Thermodynamics of electrified interface equations; Ion transport in solution: Debye Huckel-Onsager equation, Derivation of electrocapillarity: Lippmann equations, Structure of electrified interfaces, Over potential, Derivation of ButlerVolmer equation, Tafel plot; Semiconductor interfaces: Theory of double layer at semiconductor, Structure of double layer interfaces, Effect of light at semiconductor solution interface;	12
2	**Electrochemistry-II:** Electrolytic conductance, ionic mobility, transport number, Kohlrausch's law; Activity and activity coefficient, Ionic strength, Debye-Huckel limiting law and its verification, Degree of dissociation and its determination, Determination of activity coefficient by freezing point, Vapour pressure and solubility measurement. Fuel cell, Corrosion and theory of corrosion, corrosion monitoring and prevention; Electromotive force, Measurement of EMF, EMF and free energy, enthalpy and entropy; Thermodynamics of reversible cells, Electrode potential in terms of osmotic pressure and solution pressure. Nernst equation relating electrode potential and concentration.	12
3	**Surface Chemistry:** Adsorption, Surface tension, Capillary action, Pressure difference across curved surface (Laplace equation), Vapour pressure of droplets (Kelvin equation), Gibb's adsorption isotherm, Estimation of surface area (BET equation), Surface films on liquids (electrokinetic phenomenon), Catalytic activity at surfaces; Surface active agents, Classification, Micellization, Hydrophobic interaction, Critical micellar concentration (CMC), Factors affecting CMC of surfactants, Counter ion Binding to micelles. Thermodynamics of micellization, Phase separation and mass action models, Solubulisation, Microemulsion, Reverse micelles.	12
4	**Solid state:** Crystal systems and lattices, Miller planes, Crystal packing, Crystal defects:	12

	Schottky defect, Frenkel defect, Color centre; line defect: Edge dislocation, screw dislocation, Extended defect: Stacking faults, subgrain boundaries and antiphase domains; Bragg's Law, Band theory, Metals and semiconductors, Types of solid state reactions	
Total		**48**

Text books:

1. J.O'M. Bockris and A.K.N. Reddy, Modern Electrochemistry, Vol. 1 & 2A and 2 B, (1998) Plenum Press, New York.
2. Y. Moroi, Micelles : Theoretical and Applied Aspects, (1992) Plenum Press, New York.
3. F.W. Billmayer, Jr., Text Book of Polymer Science, 3rd Edition (1984), Wiley-Interscience, New York.
4. A.R. West, Solid State Chemistry and its Applications, (1984) John Wiley & Sons, Singapore.
5. S. Glasstone. An introduction to electrochemistry, Macmillan.
6. Richard M. Pashley and Marilyn E. Karaman, Applied Colloid And Surface Chemistry, John wiley and sons, England
7. Hans-Jürgen Butt, Karlheinz Graf, Michael Kappl, Physics and Chemistry of Interfaces, Wiley VCH, Weinheim.
8. Walter J. Moore, Physical Chemistry , Orient Longman, London 1972..
9. Gordon M Barrow, Physical Chemistry, Tata Mcgraw-Hill, New Delhi.,

Assessment and Expectations from Class: Tutorial, Quiz, Midsem-20, Endsem-80, attendance, Punctuality, doubt clearing class, Assignments

Semester: IV **Credits: 4 (Core)**

Course No. CHE-418
Course Name: Bio-organic Chemistry

Pre-requisites: 101, 206, 312, 418

Objective and brief description on course and expectations: The student will learn about the real chemistry of life that involve carbohydrates, aminoacids, nuclei acids and proteins. They will understand the mechanism going on in biological life (DNA, RNA, NADH).

Course Details:

Chapter/ Unit	Contents	Hours/ Semester
1	**Chemistry of Carbohydrates and Lipids:** Sugar monomers & their configurations, Structure of polysaccharides: starch and glycogen, Structure and biological functions of glucoaminoglycans, Carbohydrate metabolism: Photosynthesis, Kreb's cycle, Glycogenolysis. Characterization and degradation of Fatty acids, Oils.	12
2	**Chemistry of Amino acids and Proteins:** Amino acids, Peptides and Proteins, Chemical and enzymatic hydrolysis of proteins to peptides, Amino acid sequencencing,Primary structure proteins, Secondary structure proteins: α-helix, βsheet, super secondary structure, triplex helix structure of collagen. Tertiary structure of proteins, folding and domain structure. Quaternary structure, Amino acid metabolism: degradation and bio synthesis of Proline, valine and isoleucine.	12
3	**Chemistry of Nucleic acids:** Purine and pyramidines bases of nucleic acids, Pairing via hydrogen bonding, Structure of ribo nucleic acid (R.N.A) and de-	12

	oxyribo nucleic acid (D.N.A), Double helix model of DNA, Chemical and enzymatic hydrolysis of nucleic acid, The chemical basis of heredity, An overview of replication of DNA, Transcription, Translation and Genetic code.	
4	**Mechanisms in Biological Chemistry:** Nature's oxidizing agent (NAD^+), Nature's reducing agent (NADH), ATP, ADP, Phosphoenolpyruvate, Mechanism of glycolysis and citric acid cycle, amino acid ammonia lyases, Synthesis of Haemoglobin and its function, DNA synthesis.	12
Total		**48**

Textbooks:

1. Principle of Biochemistry (Lehninger): D. L. Nelson and M. M. Cox, W. H. Freeman and company, New York.
2. Fundamentals of Biochemistry: D. Voet, J. G. Voet and C. W. Pratt; John wiley and sons.
3. Bioinorganic Chemistry: Bertini, Gray, Lippard, Valentine, Viva Books Private Limited.
4. Outlines of Biochemistry by Eric Conn, Paul Stumpf, George Bruening & Roy H. Doi, John Wiley & Sons
5. Organic Chemistry by Clayden, Greeves and Warren, Oxford Univ. Press, 2nd Ed (2012).
6. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Part A and B Springer, 5th Ed.(2005)
7. A Guide Book of Mechanism in Organic Chemistry, Peter Sykes, Longman.6th Ed.(1999)
8. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press,3rd (1957).
9. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall, 6th Ed.(1992)

Assessment and Expectations from Class: Tutorial, Quiz, Midsem-20, Endsem-80, attendance, Punctuality, doubt clearing class, Assignments

Semester: IV **Credits: 4 (Core)**

Course No. CHE-419
Course Name: Polymer Chemistry

Pre-requisites: Basic Organic & Physical chemistry.

Objective and brief description on course and expectations : The student will learn about Structure and Properties, Basics of Polymer; Polymer Characterization; Structure and Properties;

Course Details:

Chapter/ Unit	Contents	Hours/ Semester
1	**Basics of Polymer:** Importance of polymers, Basic concepts: Monomer, repeat units, degree of polymerization, Linear, branched and network polymers, Classification of polymers, Polymerization: Condensation, addition, radical and coordination polymerization, Polymerization conditions and polymer reactions, Polymerization in homogenous and heterogeneous systems.	12
2	**Polymer Characterization:** Polydispersion-average molecular concept, Number, weight and viscocity average molecular weights, Polydispersity and molecular weight distribution, Practical significance of molecular weight, Measurement of molecular weights, End group, viscosity, Light scattering, osmotic and ultracentrifugation methods, Analysis and testing of polymers,	12

	chemical analysis of polymers, Spectroscopic methods, X-ray diffraction study, Microscopy, Thermal analysis and physical testing-tensile strength, Fatigue impact, Tear resistance, Hardness and abrasion resistance.	
3	**Structure and Properties:** Morphology and order in crystalline polymers-centrifugation of polymer chains, Crystal structure of polymers, Morphology of crystalline polymers, strain induced morphology, crystallization and melting, Polymer structure and physical properties-crystalline melting point, melting points of homogenous series, effect of chain flexibility and other steric factors, entropy and heat of fusion, Glass transition temperature, Tg, Relationship between Tm and Tg, effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking, Property requirements and polymer utilization	12
4	**Properties of Commercial Polymers:** Polyethylene, poly vinyl chloride, polyamides, phenolic resins, epoxy resins and silicone polymers, Functional polymers- Fire retarding polymers and electrically conducting polymers, Biomedical polymers –contact lens, dental polymers, artificial heart, kidney, skin and blood cells.	12
Total		**48**

Textbooks :

1. Textbook of Polymer Science: F. W. Billmeyer Jr, Wiley
2. Polymer Science: V. R. Gowariker, N. V. Biswanathan and J. Sreedhar, Wiley, Eastern.
3. Physics and Chemistry of Polymers: J. M. G. Cowie, Blackie Academic and Professional.

Assessment and Expectations from Class: Tutorial, Quiz, Midsem-20, Endsem-80, attendance, Punctuality, doubt clearing class, Assignments

Semester: IV Credits: 4

Course No. CHE-420

Course Name: Dissertation

Pre-requisites: All semesters theory & practical papers.

Objective and brief description on course and expectations : The student will work in real in some national laboratory/state or at SKCG(A) College of his/her choice. The student will inform ahead regarding where she/he is interested to work, provided with a consent letter from respective supervisor. Each student has to work for at least 300 hours in a reputed research laboratory or industry on a specific project under the guidance.

The dissertation supervisor:

a) Professor/Associate Professor/Assistant Professor/Reader/lecturer/ Scientist/Scientific officer (having at least PhD degree).

b) The research work will be submitted in the form of a dissertation within one week of last theory examination/as instructed by HOD. The student has to present his work in power point before an External examiner and an Internal examiner for evaluation.

Chapter	**Contents**	Hours/ Semester
1	Literature review	20
2	Learning objectives	20
3	Dissertation work along with instrumental technique	230
4	Report writing in proper format	30
Total		300